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THE CAUSE AND REMEDY FOR BUSINESS DEPRESSION.

By Edward Atkinson.

I HAVE been asked by the editor of the ENGINEERING MAGAZINE to review "the present conditions of business" in this country, and to point out the causes by which our progress in material welfare has of late been retarded. The terms of this request are in the following words: "An appeal to business men is called for, to sweep away the interference of the politicians."

It is not difficult to deal with the present condition of business, and it is easy to denounce the misdoings of politicians in general terms. No remedy will be found, however, for the evils under which we are suffering, until the definite source of the admitted depression and distrust is reached and the remedy applied. We may denounce political action; yet neither confidence or credit can be fully restored without legislative action, which implies political action. It is admitted by politicians of all types that the sources of present distrust and discredit by which what is called "the business of the country" is retarded are to be found in political and legislative action in the past. The remedy has in part been found in the repeal of an act of congress known as the Sherman act, and may yet be found in the repeal of other bad acts rather than in the enactment of new statutes.

The invention of money preceded the invention of coinage. After that invention had been placed at the service of mankind in an early period in economic history, it became evident that the precious metals, so-called,—silver and gold,—had become by natural selection the money metals, displacing cattle, skins, copper, iron, and other valuable articles which had previously served the purpose of money. After public coinage had displaced private coinage,—the object of rulers in assuming the function of coinage being at first to assure just

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and equal weight and quality in every coin,—legislation, or the decree of rulers, began to affect monetary conditions.

Under the pretext of a coinage act an effort has been made to force silver into use as money without regard to its bullion value, beginning with the so-called Bland act of 1878, followed by the so-called Sherman act of 1890, now culminating in the demand for free coinage of silver into dollars at the ratio by weight of sixteen of silver to one of gold. The promoters of these acts propose to force the people of this country to accept dollars made of silver costing only fifty to sixty cents each as a legal tender in place of dollars made of gold or its equivalent.

That such an act of force or legal tender is wholly without warrant and uncalled for is proved by all the conditions of international commerce. There is no international act of legal tender. The object of the so-called bimetallic treaty is simply to bring the force of a legal-tender act into international commerce, which is now free from any such compulsory measure. The whole commerce of the globe, nation with nation and section with section, is conducted in terms of money, almost wholly in the "pound sterling." Contracts made in that monetary term, "pound sterling," can be liquidated or satisfied only by the weight of 113.0016 grains of pure gold to each pound.

The price of all the great crops of this country, of which, on the average, fifteen per cent. have been exported year by year for the last ten years, is fixed by their valuation for export on the gold basis. By that fact the domestic commerce of this country is bound to the single gold standard or unit of value, whether we will or no.

We have sold to the machine-using, gold standard nations—Great Britain and her colonies, France, Germany, Holland, and Belgium—our excess of food, fibres, and fabrics to the extent of eighty-three per cent. of all our exports. The gold value of our exports (mainly consisting of the products of agriculture) in the last decade, in excess of our imports from these specific countries, has been, in round figures, $2,500,000,000. The advocates of the free coinage of silver dollars of full legal tender propose to enable the bankers of Europe to gather in the silver bullion of the world, of which the market value is now 68 cents per ounce, to send it to our mints to be coined without charge, and then to force it upon our farmers, wage-earners, and other persons at $1.29 ½ an ounce, thus cheating them out of about half their dues for the benefit of two privileged classes,—the silver miners of the west and the foreign bankers and their agents of the east.

Such being the facts, the source of the present discredit and depression may surely be found in the Bland and Sherman acts, under which the demand debt of the United States was increased, by an is-

sue of notes or promises to pay, by nearly five hundred million dollars for the purchase of silver bullion which, when coined into dollars at sixteen to one, is bad money. We may easily trace the cause of our present bad conditions to the enforced use of bad money. Bad money is any coin of full legal tender which is not worth as much after it is melted as it purported to be under the act of legal tender or on its face. Bad money drives good money out of circulation.

A minor cause of the present discredit and distrust which pervades the community is to be found in the act of 1890 for the reduction of the revenue, the so-called Bland and Sherman acts being the prime cause. The deficiency of national revenue as compared to expenditures during the last three years has added gravely to the distrust of the community, and to the fear on the part of foreign investors of the ability of the country to maintain the integrity of its gold unit of value and to redeem bad money in good money according to the laws of the land. The very act of 1890 which caused this discredit and the deficiency of revenue made it at the same time the duty of the executive officers of the nation to maintain the parity of all instruments of exchange at the present standard or unit of value of the nation,—namely, a dollar made of gold,—without supplying adequate means. Under the acts of 1890 affecting revenue and expenditure, the revenue taxes upon sugar, which had for a long term of years yielded ninety-two cents per head, were removed. A bounty on sugar was granted. Other acts were passed very greatly increasing the expenditures of the country, while very largely diminishing the revenue. Except for this legislation of 1890, the revenue from sugar only would have yielded, from 1891 to 1895 inclusive, a sum of one hundred and fifty to two hundred million dollars in excess of the deficiency of revenue which has since ensued.

On the other hand, except for the increased expenditures of 1891 to 1895 inclusive under the acts of 1890, as compared to the rate of expenditure of the previous five years, there would have been no deficiency, even with the sugar tax removed. In other words, the acts of congress of 1890 have led to a deficiency in the subsequent five years, when, had it not been for that legislation, the national debt would have been diminished in a sum of over four hundred million dollars in the period from 1891 to 1895. (See subsequent statement.)

The penalty of this mis-legislation has been met in the panic of 1893, and the long subsequent struggle to restore the credit of the nation and the confidence of the business community. In support of these statements the subsequent tables are submitted, derived from the official accounts of the nation brought down to the end of the last fiscal year.

TABLE 1.

Analysis of the Receipts and Expenditures of the United States for sixteen years, including fiscal years ending June 30, 1879 (gold payment resumed Jan. 1, 1879), to June 30, 1895, inclusive.

Revenue, sixteen years, 1879 to 1895 inc.

		Per head.
Taxes collected upon liquors and tobacco, domestic and foreign	$2,503,422,382.	2.50
Taxes collected upon sugar	649,019,968.	.65
Miscellaneous receipts, public lands, &c	405,450,188.	.40
All other taxes, mostly duties on imports	2,503,483,875.	2.50
Total	$6,061,376,413.	$6.05

Expenditures, sixteen years.

Normal cost of government—judicial, legislative, army, navy, rivers and harbors, public buildings, and all else except interest and pensions,	$2,594,583,640.	2.60
Interest and pensions	2,382,003,200.	2.38
Applied to reduction of debt	1,084,789,573.	1.07
	$6,061,376,413.	$6.05

TABLE 2.

Revenue and expenditures, 11 years (1879 to 1890), and 5 years (1891 to 1895), contrasted.

Revenue.	1879 to 1890	Per head	1891 to 1895	Per head.
Liquors and tobacco	1,648,979,569	2.47	854,442,813	2.55
Sugar,	599,928,621	.90	49,091,347	.15
Misc. receipts	296,632,708	.44	108,817,480	.33
Misc. duties,	1,772,353,562	2.66	731,130,313	2.19
	$4,317,894,460	$6.47	$1,743,481,953	$5.22
Expenditures.				
Normal cost of gov't	1,635,127,249	2.44	959,656,391	2.87
Int. and pensions	1,534,065,044	2.30	847,938,156	2.53
	3,169,192,293	4.74	1,807,594,547	5.40
Surplus '79 to '90	1,148,702,167	1.73		
	$4,317,894,460	$6.47		
Deficiency '91 to '95			64,012,594	.18
			$1,743,581,953	$5.22

It will be remarked that the average population in the first period was 60,000,000 ; in the second, 66,000,000. It is now over 71,000,000. Each dollar per head of revenue or expenditure, therefore, now represents over $71,000,000. The revenues are increasing in the present fiscal year, and the expenditures have been brought back to the average of the whole period from 1879 to 1895 inclusive,—namely, five dollars per head.

TABLE 3.

The variations in the total revenue and expenditures are given year by year in the subsequent table, together with the revenue from liquors, tobacco, and sugar, the expenditures also being separated :

Year.	Revenue per head.	Expenditure per head.	Revenue liquors and tobacco.	Revenue from sugar.	Cost of government.	Interest and pensions.
1879	5.56	5.46	2.31	.82	2.59	2.87
1880	6.67	5.28	2.46	.82	2.24	3.04
1881	7.03	5.06	2.63	.93	2.47	2.59
1882	7.69	4.91	2.79	.94	2.39	2.52
1883	7.42	4.95	2.80	.86	2.62	2.33
1884	6.34	4.44	2.44	.90	2.44	2.00
1885	5.78	4.63	2.25	.93	2.72	1.91
1886	5.86	4.23	2.30	.90	2.24	1.99
1887	6.32	4.56	2.37	.97	2.47	2.09
1888	6.32	4.33	2.34	.85	2.25	2.08
1889	6.24	4.60	2.43	.90	2.50	2.10
1890	6.44	4.69	2.61	.86	2.43	2.26
1891	6.13	5.55	2.66	.50	3.02	2.53
1892	5.42	5.27	2.73	.02	2.85	2.42
1893	5.77	5.73	2.74	.03	2.92	2.79
1894	4.36	5.39	2.43	.04	2.91	2.48
1895	4.49	5.11	2.36	.23	2.64	2.47
Averages	$6.05	$4.98	$2.50	.65	$2.60	$2.38

It will be remarked that the revenue from liquors and tobacco has sufficed to cover the normal cost of government within ten cents, which ten cents is substantially the *per capita* of the refund of direct taxes, the sugar bounties, and other abnormal payments which will not recur.

The falling-off in revenue from liquors and tobacco after 1883 is due to reductions of duties on tobacco ; the revenue from whiskey is substantially uniform ; that from beer has rapidly increased.

The tendency of the revenue from liquors and tobacco is to increase *per capita*, for the tendency of the normal cost of government is to diminish when judgment and economy are properly exercised ; the tendency of pensions is to diminish very rapidly, much as we may deplore the cause of such reduction.

TABLE 4.

The population which would have borne a sugar duty from 1891 to 1895 averaged 66,000,000 : for five years, 330,000,000.

The net loss of revenue from the repeal of the tax on sugar was 75 cents per head.....	$247,800,000
The increase of expenditure as compared to the previous eleven years was 66 cents per head.....	217,800,000
Total loss of revenue and increase of expenditures due to the legislation of 1890.....	$465,300,000
Deficit from June 30, 1891, to June 30, 1895, since increased.....	64,012,594
Loss in debt payment in five years.....	$401,287,406

In other words, the loss of revenue on sugar, and the increased *per capita* expenditure from 1891 to 1895 inclusive, amount to four hundred million dollars, and this difference was caused by the monetary and revenue legislation of 1890.

It is admitted that a part of this change may be attributed to the legislation of the next congress after 1890, the purpose of which was defeated by the annulment of the proposed income tax. This act, however, came into force during the period of discredit and industrial paralysis which was caused mainly by the so-called Sherman act of 1890, increasing the demand debt of the country without providing any means to meet it, the silver bullion bought under that forced loan being rather worse than useless. It is becoming evident, however, that the existing laws for the collection of revenue will yield a surplus over normal appropriations, as soon as assurance is given that the gold unit of value will be maintained.

No doubt consumers have gained in the lower price of sugar what the treasury has lost,—namely, 90 cents per head,—but, when the fact becomes plain that, by restoring that duty, and by putting a duty on tea of 20 cents a pound and on coffee of 5 cents, a revenue of 60 cents per head may be secured, which additions to present revenues would suffice, not only to meet all expenditures, but to pay off the entire bonded debt of the nation in less than ten years, or in but a little over one generation since it was incurred, one may ask the question whether it may not be worth the effort. In any event, and from whatever point of view the method of collecting the public revenue may be dealt with, these plain statements of fact must be considered.

So far as the data of the present fiscal year, ending June 30, 1896, have been disclosed, the rule developed by the foregoing tables is practically sustained,—varied but little by existing depression. Bad legis-

lation may retard, but cannot stop, the progress of this country. In spite of doubt and discredit, the power of this country to adjust its business to almost any legislation is now being demonstrated in the slow improvement of conditions, and yet more in the rapid increase in the exports of manufactured goods to the relief of the overstocked domestic market. At the time of this writing (May, 1896) there are also some indications that even the members of the present congress have begun to see the hand-writing on the wall. Genuine efforts appear to be now under way to overcome the deficiency of revenue, either by increasing the tax on beer or by some one of the very simple methods which would be apparent to any but ill-conditioned politicians who give more regard to partisan success than to the interest of the country. Witness the previous utter refusal of men in both so-called parties to deal with the revenue question on its merits, each insisting upon loading any measure offered with amendments directed to some ulterior purpose not germane to the simple undertaking to provide for the existing deficiency.

The facts disclosed in this table prove in the most conclusive manner that the expenditures of this nation, economically administered, have been amply covered in the past, and may be again in the future, at a *per capita* rate of $5, which is less than one half the taxation for national purposes of Great Britain and Germany, and less than a third that of France. It is also made plain that, under the acts as they existed for the greater portion of the sixteen years (without the last increase in the rate of tax on whiskey per gallon,—an increase of doubtful expedience), liquors and tobacco, domestic and foreign, have yielded, and would yield, a steady and substantially regular revenue to the government at the rate of $2.50 per head.

It is also made plain that a tax upon sugar of two cents a pound, equitably collected, amounted during the period in which that was substantially the rate to ninety cents per head..... .90

It is also made plain that the miscellaneous receipts have been forty cents, and may continue to be not less than twenty-five cents, per head..... .25

It has also been proved by previous experience that a tax of twenty cents a pound on tea and five cents a pound on coffee formerly made no appreciable difference in the consumption of these articles. At the average rate of consumption, these two taxes would now yield per head sixty cents..... .60

Making a total revenue from these sources of four dollars and a quarter..... $4.25

Allowing for contingencies, we have, say, four dollars with which to

meet the expenditure of five dollars per head, leaving a necessity for the collection of revenue at the rate of one dollar a year, or, to cover contingencies, one dollar and a half a year, making a total assessment of $5.50 per head from a population now exceeding 71,000,000. At $5.50 per head the revenue of the next fiscal year would exceed $400,000,000,—postal revenue not included, as that is practically covered by postal receipts.

The present tariff, imperfect and unsatisfactory as it may be to either party, may be depended upon to yield a revenue under normal conditions of more than one dollar, probably one dollar and a half, per head in the next ten years, during which period this business method would yield an excess of revenue over and above all obligations, including the present pension roll. That pension roll, however, may be rapidly reduced. Hence it follows that, if the present emergency were met by a temporary tax on tea and coffee, or by a temporary increase of the tax on beer of seventy-five cents to one dollar additional, such a tax might not long be needed; after serving its purpose for three or four years, it would be repealed, unless the country should conclude to collect its revenue permanently by putting the taxes or duties on articles of universal consumption,—taxes which the government surely would receive at the least possible cost of collection.

The signs of the times indicate that the business community demands the settlement of the money question, and will insist upon the maintenance of the gold standard of value by the party succeeding at the ensuing election. Is it not also manifest that the business community, and a large portion of the manufacturing community, demand a rest from tariff legislation, until the effect of the existing laws may be worked out under normal conditions of stability, restored confidence, and relief from the effect of the late financial panic? Such a business-like adjustment to meet the present conditions may perhaps meet a general support from moderate men arrayed on either side of the tariff question.

What the business community now needs is rest from the uncertainty of tariff changes, even though it be true that the influence of prospective changes is greater upon the imagination than upon actual business.

The movement of chambers of commerce, boards of trade, and other similar bodies, and the proposed conventions of delegates from them to deal with the present causes of depression and distrust, are signs of the times by which politicians must be governed.

In conclusion, one may venture to make an approximate estimate, in terms of money, of the amount of the business transactions of this country in a single year, omitting all transactions in land,

stocks, bonds, or anything of an exchangeable kind except the necessaries of life,—food, fuel, shelter, and clothing.

The business transactions, the purchases and sales of every working-day in the year at the present time, which become necessary in the process of supplying daily wants, amount, in terms of money, to not less than one hundred million dollars per day. Money of some kind is the necessary instrument of exchange. In the conduct of this enormous traffic there must be a unit or standard of value, in order that the work may be done most effectively. If the slightest doubt affects the credit of that standard or unit of value, all credit suffers; then arises what we call "depression in business." The lack of comprehension of this fundamental principle, and the lack of any apparent intention on the part of the present congress to deal with the causes of the present discredit and depression, constitute the evil to which business men are now giving their attention, and which it is their purpose to remove.

On the other hand, when the stability of the unit of value is assured, the redemption of all the obligations entered into by business men is also so well assured that the losses by bad debts incurred in the conduct of this vast exchange of products for mutual benefit come to less than a quarter of one per cent., or less than twenty-five cents on each hundred dollars of credit granted and received. The farmer who grants a credit season by season when he plants his crop months before the harvest; the mechanic who grants a credit when he makes a bargain for his month's or season's or year's work; the manufacturer who grants a credit when he buys his stock for conversion into goods for the next season's consumption; and the banker, merchant, or tradesman who grants universal credits to his customers,—are alike assured of a just return in money of the same value as that paid out or lent. When the credit of the money or unit of value is attacked, then all alike are crippled, business becomes depressed, enterprise is checked, and the evils of the panic of 1893 occur. Surely they will again occur, if the cause is not removed.

It is not difficult for any person to imagine the malignant influence of any obstruction which legislators may place in the way of this work. Let the great volume of traffic be retarded by only five per cent.; let five million dollars' worth of traffic a day be stopped by discredit,—and the goods which others need are held back, depressing the price and apparently over-stocking the market, while five per cent. of the consumers, perhaps a thousand miles away, are reduced in some measure to compulsory idleness, others to short hours, others to a reduction of wages. Five per cent. of 24,000,000 workers is 1,200,000.

Suppose the discredit to the coin of the nation assumes a graver aspect, what then occurs? The answer to that question need not be put in theory; the discredit caused by the Bland and Sherman acts, and their necessary and long-predicted consequences, were made manifest in the paralysis of industry under the panic of 1893. The congresses of the United States, by enacting these measures for collecting a forced loan of nearly $500,000,000 by the issue of legal-tender notes or cheap dollars with which to purchase the silver bullion that now lies dead and useless in the treasury of the United States, brought into force the causes of the disasters which ensued from that panic. The repeal of the Sherman act is only the beginning of the removal of the evil.

The business men of the country are now moving with accelerating force to displace the advocates of this disastrous policy from every position of trust, honor, or influence which they now hold, while farmers, mechanics, and workingmen in every branch of occupation will demand that the money in which their earnings and wages are paid shall be good money, and not bad money. The delusion of cheap money has been dispelled, and the community has learned by disaster that cheap money is cheat money.

The cleavage in both political parties is working steadily toward their disruption. Each will then be free of the burden of the silver faction, and will unite for the maintenance of good money in full co-operation with the business men of the community. The interference of the bad-money politicians will then be swept away.

THE TURNING-POINT IN RAILWAY REFORMS.

By M. E. Ingalls.

THE year 1895 was probably the turning-point in the management of railways in this country. They were only a little over half a century old,—in fact, one of the greatest has just celebrated its semi-centennial, and very few railway corporations were in existence fifty years ago,—but in this short time they have grown to immense proportions. No better illustration of this growth can be seen than in that of the corporation just alluded to,—the Pennsylvania Railroad, one of the greatest companies in the world. Statistics were not so well kept in early days as now, but in 1852 the Pennsylvania reported that it had carried 102,000,000 tons of freight one mile, at an average rate of 3.76 cents per ton per mile. For 1895 it reports 8,173,218,403 tons of freight one mile, at the rate of .56 cent per ton per mile. Nothing like it in the history and development of the human race has been known. The combination of the iron way with the propelling power of steam has advanced the world more in fifty years than all else that had been discovered in the fifty centuries preceding. It has furnished employment to an immense army of men, most of whom require a peculiar education and training for the business. A million of men (in round numbers) are engaged in this occupation; as many more in the furnishing of supplies and material necessary for the business; and over and beyond it all is the influence which this traffic has upon the life and civilization of the nation. So that a man or woman whose life and condition are not affected by railways must live in some place practically beyond the reach of civilization.

The history of the railways in this country shows the progressiveness of the Anglo-Saxon race better perhaps than anything else that history records. Greater than any conquest of a country, greater than any other advance in civilization, has been the progress of the railways in the last fifty years. Originally constructed to aid scattered communities, and, in most cases, to connect navigable waters, they have long since neglected any connection with rivers or canals, and have carried freights in quantities and at rates that even DeWitt Clinton, when he built the Erie canal, never dreamed of. Built at enormous expense, they were allowed at first to charge rates which now seem extravagant, and were given almost unlimited privileges. Fortunes were made by some of the early adventurers, but more were lost. After a little, barnacles grew up (as they always do upon every great business), outside profits were made, and various pretences were seized upon to organize

parasites to fatten out of the business. There was also the contractor and promoter who built miles and miles of railway, taking the bonds, subsidies, stock, issuing as much as he could sell, selling it at almost any price, and in many cases pocketing fabulous profits, and leaving the poor owners of the railway, and the communities which it served, at loggerheads and angry with each other. The communities, looking at the large profits made by these contractors and harassed by business depression, turned upon the railways, and, by means of legislation, endeavored to regulate rates and secure reductions. The first and most notable attack was the Granger legislation, which was strengthened and made more acute by the panic of 1873. The railway officials themselves, encouraged and spoiled by the great power they had, in many cases were insolent and lawless, and this added to the trouble. The fight as to whether railways were public corporations and could be controlled by legislation lasted for many years, and finally culminated in the decisions of the supreme court that there were certain limitations which legislation could apply, and, ultimately, the enactment of the interstate commerce law, which endeavored to regulate all the railways in the country that were doing interstate commerce; and there were practically none that were not. This law was passed in 1887, and I think we may conclude that from that time the question was settled that railways were public corporations, subject to legislative control. Previous to that, rates were raised or reduced without any notice, and it was considered proper to make certain rates to one man secretly, and higher or lower rates to his neighbor. The fact is, however, that such practices were undoubtedly illegal under the common law, and the interstate commerce law really did not much more than put in statute form the unwritten common law of the land. It did, however, affix a penalty to the practice of giving rebates and secret considerations, and made such practices a crime. After its passage, it was accepted by the great body of railway managers, and for some little time—one year at least, and perhaps two or three—it was obeyed, and rates were fairly well maintained. Soon, however, companies in search of business began to resort to their old tricks of securing it, and by various subterfuges evaded the law; and, after the decisions in the Counselman and other cases, these practices became more bold, and even many of the lines which desired to obey the law were forced to meet the practices of their competitors or lose their business and see their companies go into bankruptcy.

Probably a worse state of affairs never existed in reference to a large business interest than that which prevailed among the railways in the early part of 1895, for which reason I stated in the beginning that that year marks the turning-point in railway management. In June, 1895,

there was held in New York a meeting of representatives of the lines between the Mississippi river and the Atlantic ocean, and north of the Ohio and Potomac. I have never before seen a body of men, managing great enterprises, so discouraged over the situation, and so hopeless of any future. Rates on grain from the Mississippi river to the ocean were being made at ten cents per hundredweight; westbound, rates from the seaboard cities at almost any figure that the shipper cared to ask for. A large number of lines were in bankruptcy, and many more which have since gone there were trembling on the brink. Because of the most utter want of faith in the promises and assertions of many railway officials and agents, their word or agreement was accepted, if at all, among each other, with the greatest distrust and suspicion, and the public generally was not slow in learning the true situation. There was then in progress an education in this suicidal method of railway business. A few of the managers present thought it worth while to attempt a reform, and, after some effort, succeeded in inducing all to join. It was then agreed by the presidents of the large railways, in the territory I have alluded to, that tariff should be maintained on and after July 12, and a committee was appointed to devise some new plan for maintaining tariffs in the future. All through the summer and fall many of the chief railway officials worked at this business, and out of it grew what is known as the Joint Traffic Association. Just as this was starting, there came the decision of the supreme court in what is known as the "Brown" case, which practically decided that parties under prosecution for giving secret rebates can be compelled to produce books and tell what they know, if they are not on trial themselves; this aided in what we were doing, and the result has been that from January 1 tariffs have been maintained practically all over the country. Other associations in other districts followed in the lead of this strong one, and in the twenty-five years that I have been managing a railroad I have never known such an adherence to tariff as we have had for four months. The burden is upon all to see that this improvement is made permanent, and, unless it is, the profession will be disgraced, and conscientious men will want to leave it and seek some other employment. If the railway business of this country is to be conducted in the future, as it was to an alarming extent for, we will say, the two years ending June 30, 1895, those of us engaged in this profession would lose the respect of ourselves and of our fellow-citizens, and deservedly so. These, I know, are strong words and harsh ones, but they are true. If, on the other hand, the business can be conducted with strict regard to law; if tariffs can be maintained and agreements enforced,—it is a business that will demand the brightest and best minds of the country.

It is undoubtedly true that the interstate commerce law requires amendment in various ways, but I am sure that these amendments will be easy to obtain, when we have shown that we can maintain the law as it is; if, however, we are to be a law unto ourselves and pay no attention to the statute, we cannot hope for any amendments.

This business is so large that it cannot be conducted as are ordinary mercantile affairs. The merchant who sells boots and shoes or clothes knows something about the price or cost, and he does not sell below cost very long. But in the railway business we employ thousands and thousands of soliciting agents, many of whom have no idea of cost, and who think their business is to secure quantity rather than revenue. They have not, nor has the public, been educated up to the fact that giving away transportation is giving away money. A man asks for a pass from St. Louis to Chicago; the official thinks it costs nothing, and he thinks he is getting what is of value to him, but of no value to the railroad. If the official were educated to the point where he could see that he gives away fifteen dollars when he gives away a pass to Chicago and return, and if the petitioner understood that he asks for that amount of money and receives it, there would not be so many passes asked for or given. The same is true of reduced freight rates; when railway managers and shippers learn that two-thirds of the business at full tariff pays more than a hundred per cent. at half rates, rates will be maintained better. There has been a great education in this respect, and among railway owners and managers there is a large advancement. Fifteen or twenty years ago a man who had the reputation of being smart at getting business by surreptitious means was in demand. To-day he hunts a long time before he gets a position; and, when he gets one, instead of attempting to make his reputation by having it known that he is cutting rates to secure business, he endeavors to build up a reputation for conservatism. This all shows a gradual education of the community, which in the end will produce beneficial results.

The railway officials of this country must be educated to respect their tariffs, and, unless they do respect them, there is no future for railways. Tariffs should be made by the directors, and, when once made and published, they should not be changed, except by the same authority. Freight and passenger men should be taught that they are employed to secure business at tariff, and not by reducing it; that they can present the advantages of their lines as to safety, convenience, and dispatch, but that the published tariffs cannot be varied from. When this is once established, railway operations will be profitable, and railway management will be respectable.

One of the strange anomalies of the times, and one which shows

how the public conscience is debauched and has lost its regard for the law, is the fact that there seems to be more trouble to-day in maintaining tariffs and obeying the law in the cases of railways in the hands of receivers than in any others. In other words, some of these railways are still reported to be securing business by secret contracts and illegal rebates. I have no question but that these practices are unknown to the court. One of these days some judge will wake up to this situation, and put an expert upon the accounts of his receiver, and then we shall get an example that will be useful. An officer of the court surely should not be a violator of the law.

The shippers from an interior city—such, for instance, as St. Louis—and those who are engaged in the management of its railways are particularly interested in the maintenance of tariffs. Under the old plan, a few large business concerns were getting enormous rebates, and were thus able to drive out all competitors; in fact, the entire profits of some large shippers consisted of the illegal rebates which they secretly obtained from the railways. This was more disastrous to an interior city than to a city like Chicago, which had the advantage of lake transportation as well as of rail. Chicago shippers could always get concessions from the railways to meet the lake rates, and thus were enabled to attract to their city a large commerce, which, if rates had been strictly and impartially maintained, would have been more equitably apportioned. The fact that their commerce was also so much larger enabled them to sell their business at a greater profit when the railways were secretly offering the lowest freight rate to the best bidder. It will take some time to adjust business to the new state of affairs, but, if the present conditions can obtain for a short time, the shippers and the community generally will be as well satisfied as the railways. Each man will know what he has to pay, and will not have to use disreputable means in order to compete with his neighbor.

I have tried to sketch briefly the rise and development of railways, and their difficulties. I have so much faith in the ability of the men who are managing them that I have no doubt that in the future they will avoid the pitfalls of the past. I congratulate those who are connected with a business that has done so much for the world in the past and promises so much for the future.

It is pleasant to dream of what would have been if railways had not been. How could this great country of ours have been developed? Would its imperial cities have been built? Then turn to the other side of the picture, and wonder what it will be fifty years from now. Our country is so immense that, as it could not have been developed in the past except by railways, so will it be impossible to realize

the bright visions of the future that we all have, except by their aid. Fast time has come to stay, and each year the speed of passenger trains between the great cities will be increased, until the "Knickerbocker" out of St. Louis at noon will reach New York the next noon or sooner. The railway carries in its hand great promise to our country for the future. Let each official strive to make the profession an honorable one; to conduct his business so that the community will respect and honor him; above all, let him heed the admonition, "to thine own self be true."

A most admirable feature of the new era is the formation of the railway clubs. There is nothing like union and association to improve and advance men. The social features are of great advantage, but more than all and above all is the good that comes from conference. Rough edges are rubbed off, sharp competition is forgotten, and the good which can be accomplished by union is learned and remembered.

The last twenty-five years have brought about a wonderful advance in friendly feeling in the operation of rival railways. Just a little over a quarter of a century ago, when an important bridge on a certain western road was burned, the president of the competing line hoisted the flag over his own company's terminal station in celebration of the event. To-day, should a bridge go down on either of these roads, the train-despatchers would at once arrange to move the trains of the unfortunate railway over the other line, without friction or delay and without reference to the presidents or general managers,—very possibly before the higher officials had even heard of the calamity.

Great benefit to all results from association. Each railroad official may still strive for himself and his own line first, but never in forgetfulness of his duties to others and to the general public.

FILTRATION OF MUNICIPAL WATER SUPPLIES.

By Rudolph Hering.

MORE general attention is being given to the subject of filtering water supplies now than formerly, and sanitation rather than luxury is the standpoint from which it is being considered, for the following reasons :

(1) Scientific research has demonstrated that certain diseases—such, for instance, as typhoid fever, cholera, and summer diarrhœa—are caused by, or hold some relation to, certain minute organisms or pathogenic germs, bearing the generic name of bacteria, which are found in the bodies or discharges of the afflicted persons.

(2) Carefully-kept records and close observation in both Europe and America have demonstrated the fact that communities supplied with water previously polluted by the discharges from such persons have had epidemics following such pollution.

(3) Statistics and research have further demonstrated that communities partaking of water which had thus been polluted, but had been subsequently filtered, were much less affected, and sometimes almost entirely spared.

(4) Chemical and bacteriological analyses of waters made before, during, and after filtration have demonstrated the gradual reduction, and, under certain conditions, the complete removal, of specific kinds of bacteria, as well as of much of the organic matter contained in the unfiltered water. Experiments have further shown under what conditions this removal is most readily accomplished. In other words, the action of filters is now better understood.

In this short article the mention of a few of the many facts which have led to the above conclusions must suffice. Cases are numerous where wells polluted by the infiltration of typhoid discharges from near privies have caused typhoid fever among those who drank the water. The Plymouth, Pa., epidemic of typhoid fever, where more than one thousand cases and more than one hundred deaths were caused by the discharge of typhoid excrements from a single person into the mountain brook that supplied a part of the city with water is a most remarkable instance. In Burlington, Vt., epidemic diarrhœa, which in a mild form prevailed for many years, and was unquestionably caused by the sewage-polluted water-supply, totally disappeared as soon as the source was changed.

The accompanying map, showing the territory near the boundary line between Hamburg and Altona, illustrates a striking case where

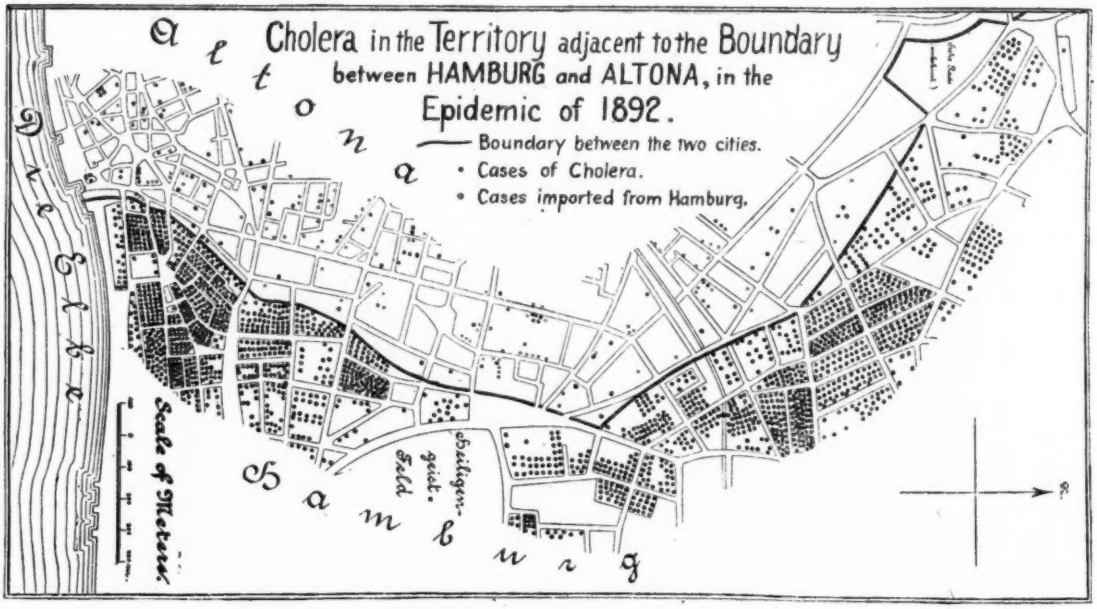


CHART SHOWING DISTRIBUTION OF CHOLERA CASES IN THE EPIDEMIC OF 1892.

the filtration of the water-supply caused immunity from cholera in the epidemic of 1892. The two cities, together having about 800,000 inhabitants, form one continuous built-up area. No person, unless informed thereof, would notice the boundary between them, which is marked on the map by a heavy line. Yet the governments are wholly distinct and independent of each other, Hamburg being a free German city, and Altona (formerly Danish) a Prussian city. Both procured their water-supplies from the sewage-polluted tidal river Elbe. Hamburg used the water as it was pumped from the river just above the city, while Altona took it below the city, but filtered it through sand filters.

The cholera epidemic started on a ship which had entered the common harbor from an infected port. The small black dots on the map indicate the resulting cases within the area shown. It is seen how few there were in Altona, and that most of these were either imported from Hamburg or were caused by using Hamburg water. The origin of the remaining cases in Altona could not be reliably traced. Filtration of the water-supply had accomplished this result. Since the Hamburg filters were put into operation in 1893, the cholera has not returned, the general death-rate has fallen, and that of typhoid fever, in particular, fell from an average of about 30 per 100,000 to 6 per 100,000.

English, German, and American investigations of recent years have demonstrated how filters act, and it is now possible by measurement and calculation to state very closely what results can be obtained by filtering water of a known degree of pollution, at a known speed and through porous material, of which the character, depth, and size of grain are also known. It has been shown that a filter, besides acting as a strainer, converts organic matter into mineral compounds, while the water is passing through the pores of the material. This conversion requires the presence of bacteria in the pores,—proven, for instance, by the fact that, when a sufficient quantity of poisonous matter which destroys them is contained in the water, or when a sufficient quantity of oxygen necessary to sustain them is not contained in it, the process ceases.

With such information the practical engineer can design his works so that they will be more efficient than formerly from a sanitary standpoint.

When filters are to do their best work, the water should have but little sediment in it. It is, therefore, desirable, and sometimes essential, first to subject it to sedimentation, so that its quality may be more uniform, and a too rapid closing up of the pores of the filter may be avoided. For this purpose settling-basins are provided, where turbid

waters are to be treated. The writer has found them used extensively in Europe, but in our country their value as a preliminary to filtration does not yet seem to be generally appreciated. A filtration plant for one of our largest cities has proved a practical failure because of the omission of such basins.

Examinations by Frankland, in England, have shown that they are useful, also, in removing from eighty to ninety per cent. of the bacteria, which are carried down with the suspended matter.

James P. Kirkwood, one of the ablest of American engineers, as early as 1866 suggested their necessity as a preliminary to filtering the water-supply of St. Louis. Since the recent extensions built under the efficient direction of Mr. M. L. Holman, water commissioner, that city has the largest series of settling-basins in the country. They are designed on the "filling and drawing" plan,—that is, the water is given an opportunity for quiet settlement, instead of passing through the basins with a continuous, but very slight, flow. One day is allowed for settlement, during which time the water is materially cleared for over twelve feet in depth. While this treatment improves the water to a great degree, turbidity still prevails during the spring and summer freshet periods. It has been suggested that the Mississippi water be clarified at such times by the addition of precipitants, such as alum, but no decision has yet been reached, nor has any specific plan of filtration yet been adopted. The accompanying views show the new settling basins and the method of cleaning. (See pages 637, 642, 643.)

The methods of filtration available for further purifying the water-supplies of cities may be divided into two classes,—rapid and slow. By the former method we may filter as much as 300 cubic feet per square foot of surface per day, and obtain a thorough clarification and a removal of 98 to 99 per cent. of the bacteria, but no removal of dissolved organic matter. By the slow method we filter from 5 to 10 cubic feet per square foot of surface per day, and obtain a surer and more complete removal of both bacteria and dissolved matter.

If much dissolved organic matter remains in the water, a subsequent fermentation and a renewed bacterial growth may take place. The rapid method is, therefore, not as efficient as the slow method, but the purification obtained by it may in many cases be quite sufficient; and, if it be accomplished at a less expense, and the necessarily large waste of water required for cleaning be not objectionable, it would naturally often be preferable to the slow method.

Rapid filters depend for their sanitary effectiveness not only upon a carefully-selected sand, the grain being of definite and uniform size, but also upon a coagulation of the organic matter and the formation of a gelatinous deposit or film upon the top of the sand. To produce

the coagulation, it is necessary to add to the raw water certain materials, alum being the most common. The bacteria are then carried down with the precipitate, and prevented by the gelatinous film from passing through the pores of the filter.

In some filters iron is used instead of alum, as in the Anderson process at Antwerp, and the Sellers process at Wilmington, Del.

As it necessarily takes time for the film to form (according to some authorities at least thirty minutes), as its continuity can easily be destroyed, and as it is, in fact, wholly removed every time the filter is cleaned, it will be seen that considerable skill and care are required to prevent a large proportion of bacteria from occasionally passing through the filter and appearing in the effluent water.

So-called pressure filters, where the water is forced through the filter under a considerable and varying head, are not as effective as gravity filters, where the pressure is lighter and more uniform, and therefore less likely to injure the continuity of the gelatinous film. The latter are, therefore, preferable for domestic water-supplies.

Mechanical filters may save the building of settling-tanks for prior sedimentation in cases where these would be advisable for slow filtration; such cases, however, are infrequent.

A valuable report prepared by Mr. E. B. Weston, C.E., has lately been issued, as an appendix to the annual report of the Rhode Island State board of health, which describes experiments made in Providence, R. I, with a Morison mechanical filter thirty inches in diameter. This is the first instance, the writer believes, where careful and prolonged tests of the bacterial efficiency of any rapid filter have been made. The city of Louisville, Ky., is now conducting a more extensive series of experiments with three or four rapid filters of large size, which promise further valuable results, both bacteriological and chemical.

The conclusions reached in Providence point to a preference for alum as a coagulant, added to the water in the proportion of about half a grain per gallon. The water is said to have been filtered successfully at the rate of 90,000,000 to 193,000,000 gallons per acre in twenty-four hours. The removal of from 70 to 80 per cent. of the color from the water was effected. The washing of the filter was found to be easily accomplished in about eleven minutes, with a quantity of water averaging about five per cent. of that filtered during each run. The quantity which had to run to waste after washing, until a proper film to retain the bacteria had again formed on the surface, averaged about three per cent. of the whole quantity, and the time for the film to become effective was thirty minutes. The average time for one run of the filter was sixteen hours and forty-three minutes. The average bacterial

purification obtained was 98.6 per cent., the lowest was 66 per cent., and this latter result was ascribed to a preventible condition. Unfortunately, but few chemical analyses were made, and the only results that are published indicate that the reduction of the organic and volatile matter was imperceptible. It was further found that the quickest and cheapest method of washing mechanical filters was by using steam and soda ash.

The estimated cost of a plant for filtering 15,000,000 gallons daily for Providence is given by Mr. Weston at about $230,000. The cost of filtering 1,000,000 gallons is estimated by him at $7.86, including interest on the cost of plant, deterioration, etc.

By slow filtration a still more complete removal of bacteria may be accomplished, and in addition, the dissolved organic matter is reduced. In this process the effective sand grains and interstices are much smaller, and consequently allow of slower percolation. Like the rapid method, it removes the suspended matter, but, in addition thereto, it reduces, solely by natural processes, the color and the dissolved organic matter. It also gives greater assurance of the complete removal of pathogenic bacteria, on account of less frequent disturbance of the surface during the washing of the filter. Slow filters must, of course, also be cleaned, but at much less frequent intervals

While simple subsidence under favorable conditions may remove from 80 to 90 per cent. of bacteria, and rapid filtration from 90 to 99 per cent., slow filtration can be depended upon to remove from 98 to 100 per cent., and generally more than 99 per cent.

To get the best results it is necessary to have a constant water pressure upon the filter, because uniformity in the rate of percolation is an essential requirement. The permissible and most effective velocity for the water passing through the filter varies, of course, and must be adjusted from time to time. Special mechanical contrivances are employed to attain this result.

The belief that artificial aeration would greatly aid the purification of water has begun to vanish. Its effect is stated by Professor Drown, President of the Lehigh University, after careful experiments, as follows: "The oxidation of organic matter in water is not hastened by vigorous agitation with air or by air under pressure. The aeration of water may serve a useful purpose, by preventing stagnation, by preventing the excessive growth of algæ, by removing from water disagreeable gases, and by the oxidation of iron in solution."

Two methods of slow filtration are now advocated,—the continuous and the intermittent. The former is the more common. It implies a constant application of the water until the efficiency of the filter is so much reduced as to require the cleaning or washing of the upper

layers of the sand; this may be once a month or less often, depending, of course, on the turbidity of the water. The intermittent method requires a cessation of the filtration at intervals of one or two days, so that air can penetrate the pores of the sand and assist in the destruction of the organic matter.

In continuous filtration, as the air is at once permanently driven out of the sand, the purification depends, so far as air is concerned, entirely upon that which is dissolved in the water itself. Yet this is sufficient in many cases for all the oxidation that can take place while the water is passing through the filter. In intermittent filtration the water drains out completely after every application, thus allowing air to be drawn into the pores and to come in better contact with the water of the subsequent application.

Generally the water passes more rapidly through an intermittent filter than through a continuous one. Therefore its straining action is less perfect, and, because of the more frequent disturbance of the sand grains at every fresh application, the water is less clear. But the oxidizing efficiency of an intermittent filter is greater, and the effluent water therefore contains slightly less organic matter. So far as we know at present, there is practically no difference in the efficiency of the two processes in removing bacteria.

The preference will have to be decided according to the circumstances in each particular case. Where the water is but slightly polluted and contains a high percentage of oxygen in solution, continuous filtration is generally preferable. Where the water is greatly polluted, intermittent filtration may be the only means of making it safe for a water-supply. In a bad case it may be necessary to resort to a double treatment.

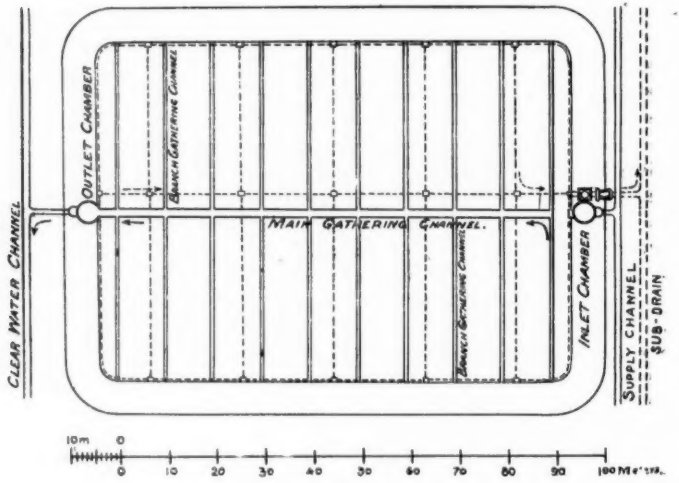
The cost of filtering water by the slow method depends very greatly on the local conditions and on the character of the water. To give a general idea of the cost, however, it may be said that filter basins, when open, can be built in the United States for an amount ranging from $30,000 to $60,000 per acre, and, when covered, from $50,000 to $90,000 per acre. One acre may be roughly considered as necessary to filter 2,000,000 gallons per day. The cost of operation, including interest on the cost of the plant, depreciation, etc., may vary from $6 to $15 per 1,000,000 gallons.

From the many works which the writer has had occasion to visit, the following two have been selected for a brief description, as they are both typical and interesting. The Hamburg works in Germany are among the largest operated on the continuous system, and the Lawrence works, in Massachusetts, were the first constructed on the intermittent system.

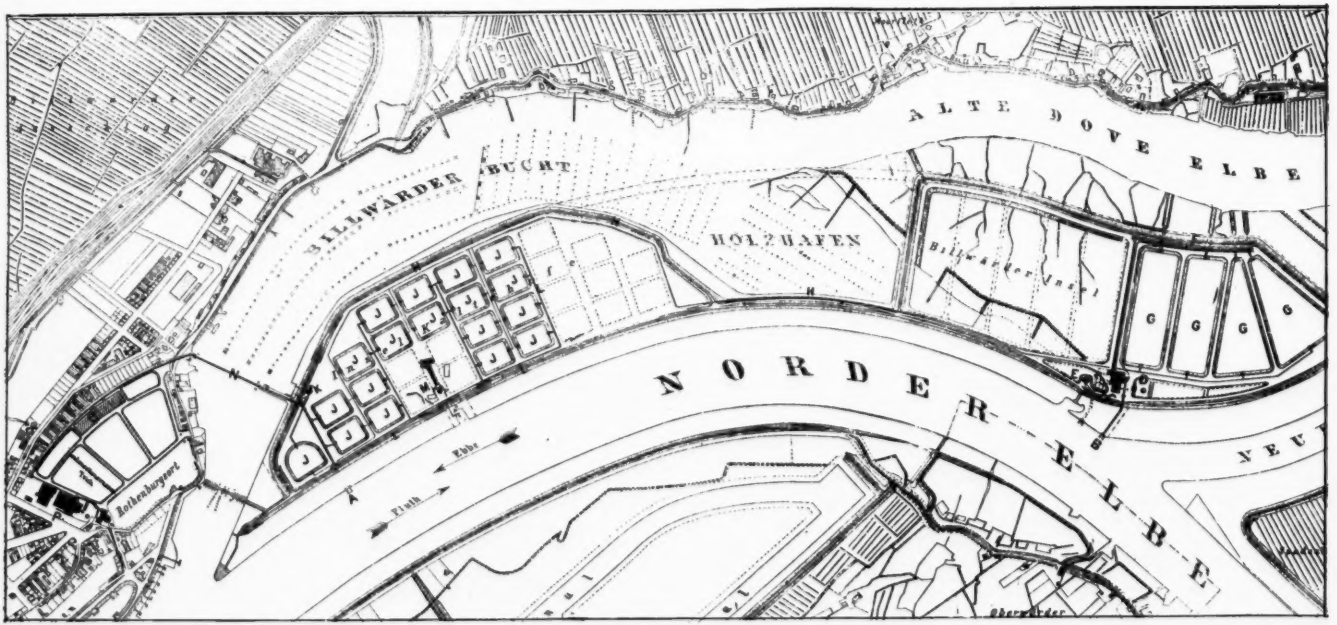
The Hamburg plant, designed by the present able chief engineer of the city, F. Andreas Meyer, was under construction at the time of the cholera epidemic in that city, in 1892, but was not put into operation until about six months after the epidemic had ceased.

The water is drawn from the river Elbe, several miles above the center of the city, and lifted with a Worthington pump into four settling-basins, each of which holds about 5,250,000 gallons. The water stands in these basins about 6½ feet deep. The time allowed for settling varies from 15 to 30 hours. The deposited sludge is flushed out into the river through a cast-iron drain 3 feet in diameter.

From the settling-basins the water flows by gravity through an 8½-foot conduit, about 1½ miles long, to the filter basins, eighteen in number. These have an effective area of nearly two acres each, and are rectangular in shape, excepting one. It is intended at present to filter 1,600,000 gallons per acre, or a depth of 4.9 feet per day. Eventually, it is thought, this rate may be doubled. The filters are open,—contrary to the general practice in Europe, which is to have them covered with masonry arches. They were made open on account of the difficulties in securing a good foundation for walls and pillars. It was thought unnecessary to incur this expense, so long as the clear or filtered water was always kept in covered channels and basins. No trouble was expected from the effect of ice, as the winter

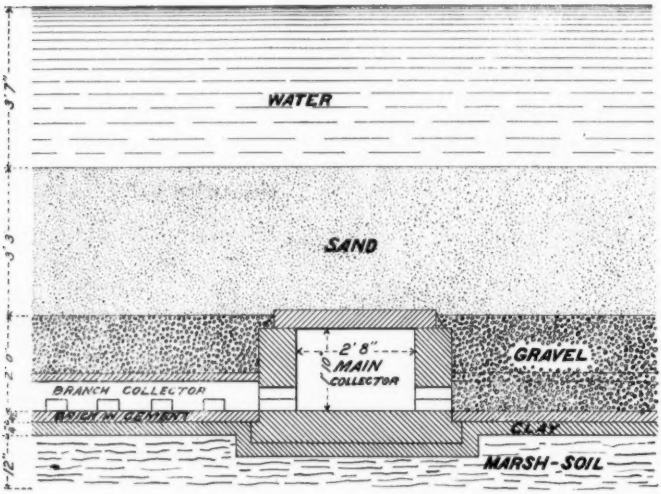


PLAN OF FILTER-BASIN IN HAMBURG.



THE HAMBURG WATER WORKS, SHOWING SETTLING-BASINS, FILTER-BASINS, AND PUMPING-STATIONS.

A. Former Intake.
B. Present Intake.
C. Pumps for Settling-basins.
D. Lighting Plant.
E. Superintendent's House.
F. Open Inlet-channel to Settling-basins.
G. Four Settling-basins.
H. Underground Supply-channel to Filter-basins.
J. Eighteen Filter-basins.
K. Pumps to Drain Filters for Cleaning.
L. Underground Clear-water Channel.
M. Laboratory for Water analysis.
N. Supply-pipe to Pumping-station.
O. Clear-water Basin, arched over.
P. Main Pumping-Station.



SECTION THROUGH HAMBURG FILTER, SHOWING COLLECTORS.

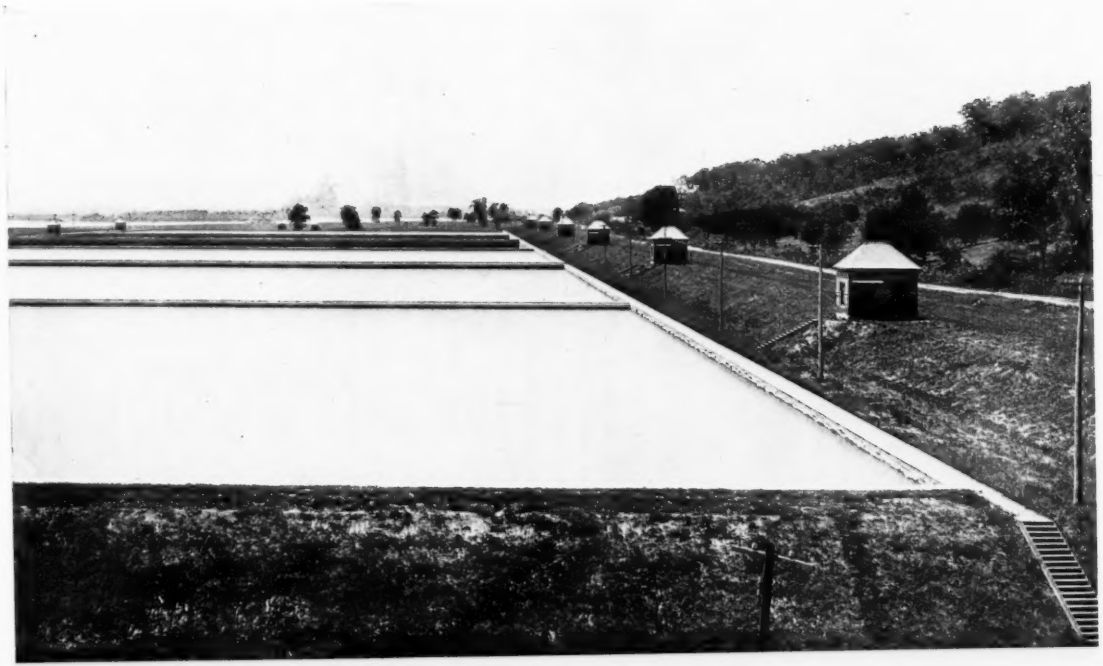
temperature is not low, and the water at such times is clearer, and the filter can, therefore, act more rapidly.

The side slopes and bottom are lined with 20 inches of well-rammed clay. Upon this are 4 inches of puddle, and finally a pavement of brick laid in cement. The main and branch collectors for the water are built as shown in the accompanying sectional drawings. The water enters these collectors through special joints in the brick-work.

Valve chambers are located on the banks, and contain self-acting valves to regulate the flow, so that a constant height of water is maintained in the filter basin.

The filtering material consists of about two feet of gravel and 40 inches of sand above it. About 16 inches of the latter is periodically removed for cleaning, and replaced. The depth of water maintained in the filters is about 4 feet. The material, before being placed, was very thoroughly washed, and then graded into various sizes, so that the coarser grains are at the bottom and the finer at the top.

To periodically clean the sand from an area of 34 acres, represented by the 18 filter basins, and varying in quantity from 90 to 235 cubic yards, depending on the season and degree of turbidity of the water, four washing plants were located, so that one could serve several basins.



GENERAL VIEW OF THE ST. LOUIS SETTLING BASINS.

Each plant has four machines, and each machine consists substantially of seven iron hoppers as shown by the drawing. A stream of clean water, with a pressure of about 16 pounds per square inch, is injected at the bottom of each hopper, stirring up the dirty sand and forcing it through a tube into the next hopper, where the same operation is repeated, until, after it settles in the seventh or last hopper, the sand is thoroughly clean. It is then loaded into trucks, and returned to the filter basin. The dirty water runs over the edge of the hopper, and then through a drain into the river. These machines are very efficient and economical. Each one requires 20 cubic yards of water per cubic yard of sand, and washes 5.2 cubic yards per hour.

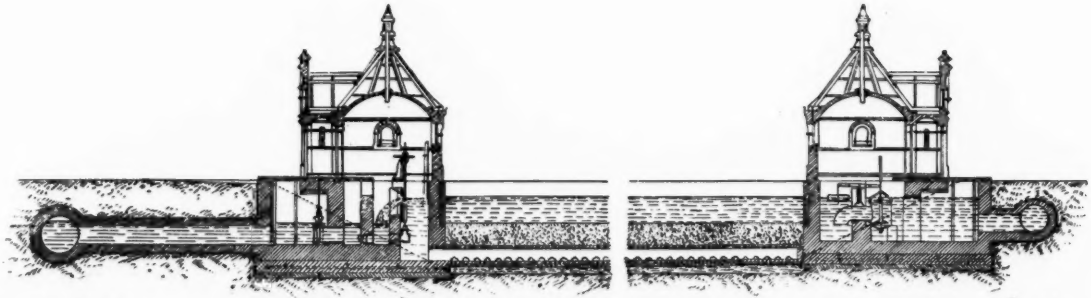
The total area appropriated for settling and filter basins is 309 acres.

The cost of the Hamburg plant including pumping machinery is $2,262,000.

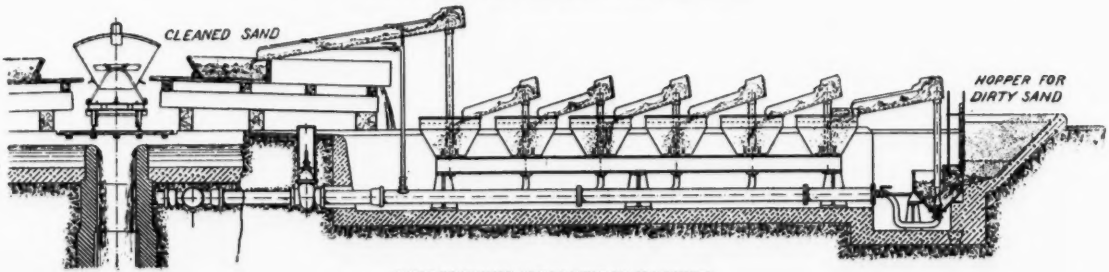
The Lawrence plant, in Massachusetts, was built under the able direction of Hiram F. Mills, C.E., member of the State board of health, and was finished in the fall of 1893. The Massachusetts board of health, in studying the typhoid fever deaths in the State, found that Lawrence had nearly three times as many per thousand persons as had other cities on an average. It was also found that they increased about one month after a similar increase had been recorded in Lowell, situated about eleven miles above on the same river. As Lawrence obtained its water-supply from this river, into which the sewage of Lowell is discharged, it was decided to build filter basins, and to purify the water according to plans suggested by the board.

The area of the basins is 2½ acres, and the proposed capacity of filtration is at the rate of 2,000,000 gallons per acre, or 6.1 cubic feet per square foot of filter area per day. The basin is situated alongside of the river, and separated from it by an embankment intended to exclude the highest spring freshets. The excavation was carried to a depth of 7 feet below low water in the river. The bottom has been left with cross-ridges, as illustrated in the sections. In the depressions, which are 30 feet apart. small drain pipes with open joints have been laid, and surrounded by small stones. These are covered by layers of stones, as shown in the section, and finally by sand of selected quality. The surface of the basin has a general level of 2½ feet below low water in the river, so that it can at all times be flooded to a depth of 18 inches.

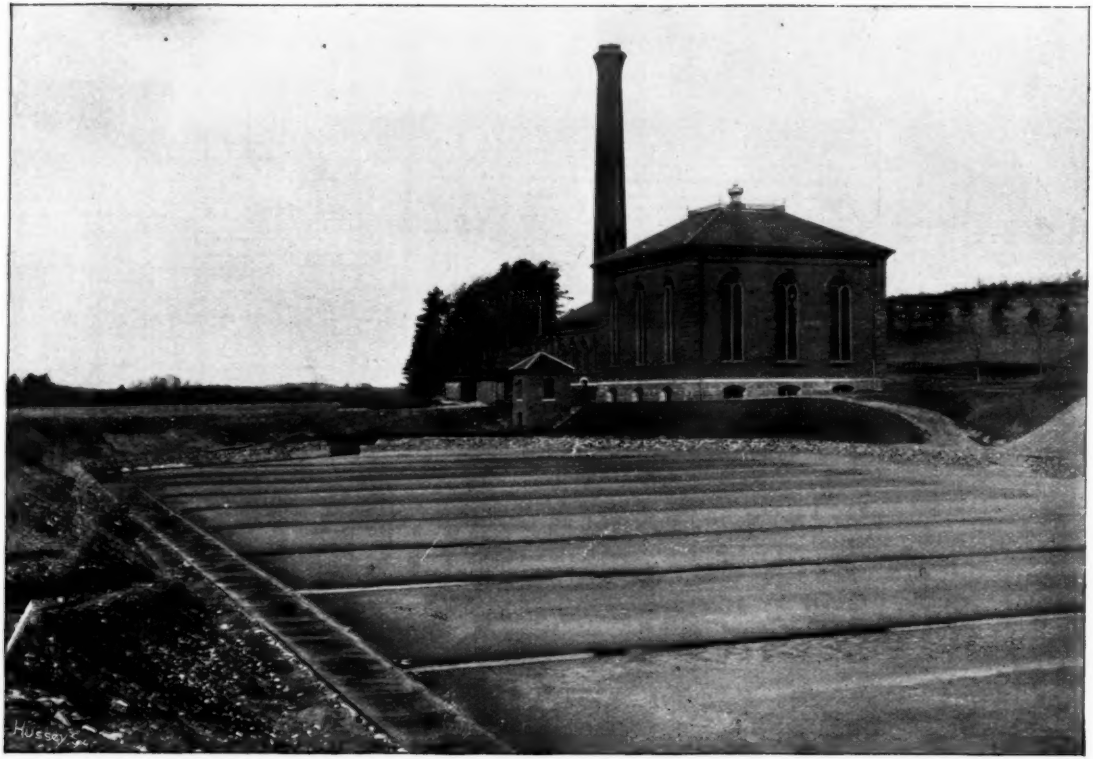
For the purpose of more evenly distributing the water over the bottom, and preventing a current sufficient to disturb the sand grains, the surface has depressions extending nearly across the basin, in which open and shallow concrete carriers are laid. See view of filter bed.



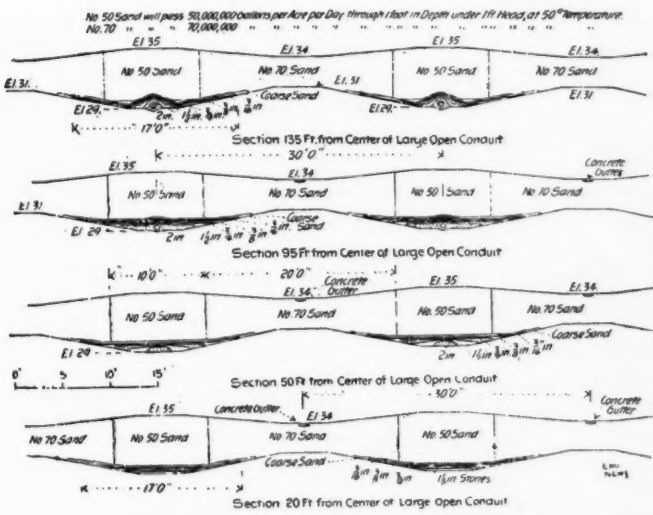
SECTION THROUGH THE HAMBURG FILTER-BASIN.



SAND WASHING APPARATUS IN HAMBURG.



THE WATER-FILTER, WITH PUMPING-STATION AND GATE-HOUSE, LAWRENCE, MASS.


No 50 Sand will pass 50,000,000 Gallons per Acre per Day through 1 foot in Depth under 1 ft Head, at 50° Temperature.
No. 70 " " " 70,000,000 " " " " " " " " " " "
El 35
El 34
El 31
El 29
No 50 Sand
No 70 Sand
Coarse Sand
17'0"
Section 135 Ft. from Center of Large Open Conduit
30'0"
Concrete Gutter
Section 95 Ft from Center of Large Open Conduit
10'0"
20'0"
Concrete Gutter
0' 5 10' 15'
Section 50 Ft from Center of Large Open Conduit
Section 20 Ft from Center of Large Open Conduit

SECTION THROUGH FILTER-BEDS, LAWRENCE, MASS.

Two kinds of sand are used, which are indicated in the section by numbers 50 and 70. The latter covers the cross ridges about 3 feet deep and 20 feet wide. The former is somewhat finer, and is placed directly over the under drains, for a width of 10 feet and a depth of about 4½ feet above the layer of stones. This distribution is intended to cause a nearly uniform rate of filtration through every square foot of the area.

The cost of the Lawrence plant was $65,000. The cost of filtering is about $7.00 per million gallons, including interest, etc.

The advantages of intermittency, the period of which in this case was twenty-four hours, were to be obtained by closing the inlet gate, which supplies the filter, about five hours before the pumps stop running for the night. By that time the basins could be drained nearly to the bottom of the sand, allowing the pores in the same to be filled with air. The inlet gate was to be opened again about an hour before the pumps start in the morning, and the surface overflowed. During the winter months, while covered with ice, the filters have been operated on the continuous system.

THE ST. LOUIS SETTLING BASINS: CLEANING OUT THE SEDIMENT.

CLEANING THE SETTLING-BASINS AT ST. LOUIS.

THE UTILIZATION OF ANTHRACITE CULM.

By Edward H. Williams, Jr.

TO the average reader the term "culm" conveys little meaning, unless he has passed through the anthracite regions, where huge mounds rise beside the railroads or form a black background to the villages grouped at their feet. The term is frequently misapplied, as its original meaning, "knots" (Welsh, *cwlmau*), was applied only to those parts of the anthracite bed which were of a knotty shape; but a derived meaning applies as well to all small pieces of anthracite. In America the rock dumps which bordered the mine mouths contained little coal till in the early fifties, as the product from the mine was sent into the market without breaking or sizing, and the only coal in the dumps came from the dirt,—pieces of "bony" or "slaty" coal which were broken down in dead work, or when room in the breasts was required, or when the cleanings from tracks, ditches, and sumps were sent outside.

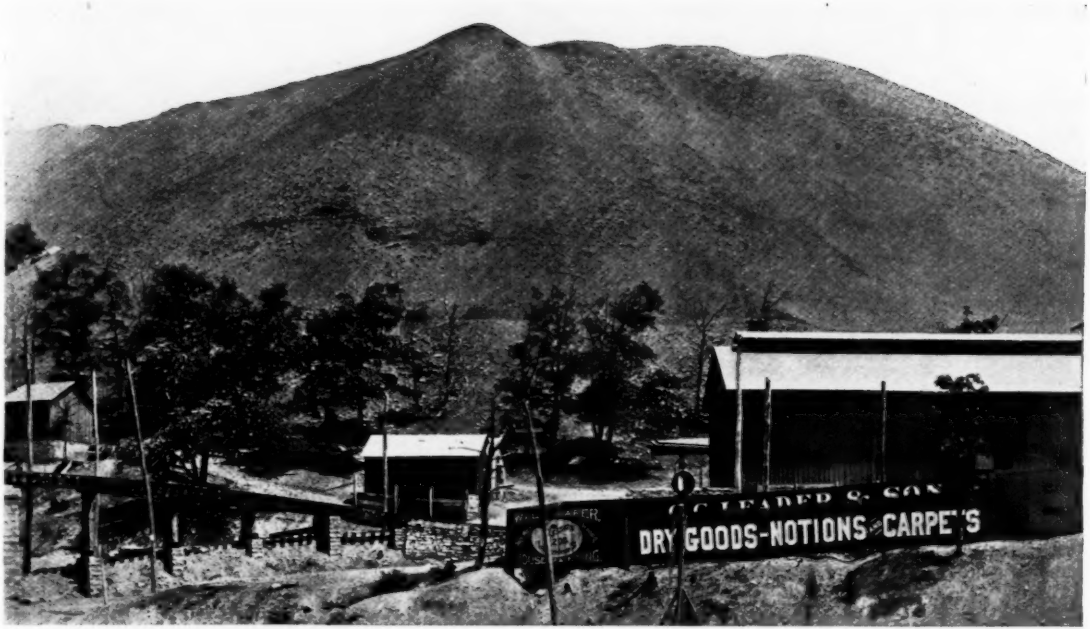
At the date mentioned coal was first broken and sized, and the air spaces in the mass were thereby increased from 37.7 to 50 per cent. of the whole, and a freer burning resulted. The grates at that period were not fitted for burning small sizes, and the smallest coal marketed was "chestnut," with diameter varying from three-quarters of an inch to one and a quarter inches. The means for cleaning the broken

THE BIG BANK AT MAHANOY CITY.

THE MOUNTAINS OF CULM AT SHAMOKIN.

masses were crude, and limited to hand-picking, so that, the smaller the size, the greater the difficulty in removing the dirt, and the smaller the demand. In many cases there were long periods when there was no sale for chestnut, or even for larger sizes, and these were thrown upon the dump, with all stuff below chestnut in size, all slate from picking, and all bony and slaty coal, so that the dumps soon received the name of "culm banks," which they still retain. The illustrations are

THE DESOLATE COAL REGIONS. CULM-BANKS AT BROWNSVILLE.



THE CULM-MOUNTAINS AGAIN : SOUTH END OF THE BANK AT SHAMOKIN.

THE BROWNSVILLE CULM-BANKS, LOOKING WEST.

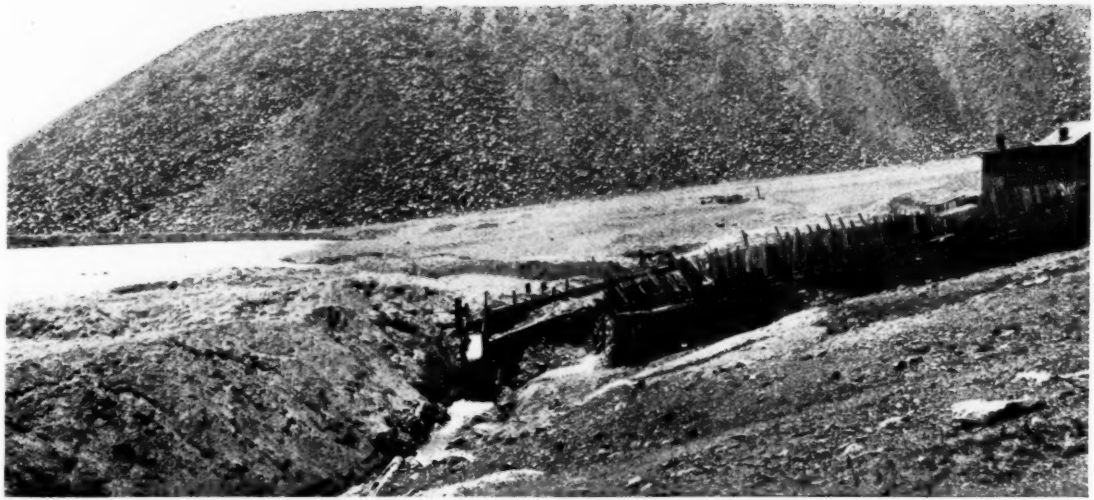
taken chiefly from near the extreme ends of the western middle basin, Mahanoy City and Brownsville lying at the eastern end, while the piles at Shamokin guard the banks of the creek of the same name where it makes its exit to the north-west. Drifton is in the northern part of the eastern middle basin.

We can estimate the amount of stuff thus thrown away by taking the production during certain periods and comparing the methods of

A GROWING BANK AT DRIFTON.

NORTH END OF THE GREAT BANK AT SHAMOKIN.

THE WASTEFULNESS OF THE PAST. ANOTHER VIEW OF THE SHAMOKIN BANK.



A CULM-BANK AT BROWNSVILLE.

coal preparation. For instance, from the early fifties, when coal was first broken, to the early sixties, when "pea" coal was first shipped to the general market ("pea" is from three-eighths to seven-eighths of an inch in diameter), 80,000,000 tons were sold, while, for every ton sent into the market, 1.3 tons went to the dump from the coal preparation alone, besides what was sent there from mining operations. The "culm" thus dumped is estimated at 100,000,000 tons.

From the early sixties to the early seventies "pea" coal was the smallest size shipped to market, fine-barred grates having been devised for its burning. The cleaning was still by hand, and the "pea" was usually dirty and commanded a low price. The amount lost in preparation was much diminished; so that 144,000,000 tons were marketed while the same quantity went on the dump. In the early seventies mechanical preparation of small-sized coal was introduced by the employment of jigs; these machines effectually separated coal and dirt, so that the use of small sizes greatly increased, and has been increasing up to date, when we are sending to market four sizes of "buckwheat" and one of "rice" coal, smaller than "pea" and clean in condition. The coal shipped during the thirty years since the introduction of jigs has averaged 25,000,000 tons per annum, and the "culm" sent to the dump during that period has steadily decreased; but a moderate estimate will place it at one-fourth of the shipment, or about 187,000,000 tons. The grand total for "culm" is, therefore, 431,000,000 tons, dumped since 1853. Adding to this the slate, rock, ashes, dirt from strippings, and other refuse, we have over 2,000,000,000 cubic yards, or sufficient to surround the world by a pile of triangular section and 20 feet high, or, estimating the workable coal that has been dumped, to cover the State of Rhode Island evenly with solid marketable coal 125 feet deep. Not all of this, and not even one-tenth of this, is now available, as will be shown later, and the loss has been in coal; the rock refuse remains. It can thus be seen that the land necessary for dumping purposes may be a serious expense when, as in the Wyoming valley, it is valuable for farming. It may further be seen that a large coal-dump over a mine adds to the weight to be supported, and, when mixed with water so as to be "quick," may seriously menace the safety of miners, should settlings or incautious drivages, as in the case at Nanticoke, allow it to flood the workings and smother the men. The fine dirt from mining and coal preparation can not be dumped where ordinary rains will carry it into water-courses, as the covering of farm lands with culm during freshets always entails loss to the companies through lawsuits. It is to the advantage of the companies to get rid of their culm banks; but their intrinsic value was little thought of in the early days of mining, as the coal-supply was

thought to be inexhaustible, and wasteful methods were employed for mining and preparation. Now that Mr. Griffiths has shown that the next generation will see the exhaustion of the greater part of the now available coal, we are turning—but too late—to our culm banks, and find but little left. The loss is due to the permission given the railroads to use the dumps as spoil-banks for grading and ballasting, or for filling deep caves whenever the underlying mines take a fancy to collapse, causing several hundred feet of track to hang across the opening like spider-webs till thousands of cubic yards of refuse fill the holes and bring back a resting-place for the suspended ties. In many cases entire dumps have been thus used.

A second method of disposal for similar reasons can be illustrated by the settling of the steeply-inclined mines under Shenandoah, Pa., where the openings were, in some cases, 70 feet high. Here the surface was pierced by numerous drill-holes, and pipes were sent down to the workings for the conveyance of culm and water to fill the workings and prevent further settling. The superincumbent water was pumped out after the solid stuff settled, and another volume of mixture was sent in till the openings were entirely filled. The mine water is highly charged with sulphate of iron, and this, being unstable and having a high affinity for oxygen, broke up into sulphuric acid and peroxid of iron (or iron rust), the acid attacking the alumina of the slates and forming alum, and iron and alum forming a solid matrix to bind together the mass, so that, after drying, the filling was found to be solid enough to sustain itself and allow drivages to be made through it without timber, as in the solid coal. This method of disposal will doubtless be employed in future with the worthless material from the jigs, and combined with underground workings, so that the coal can be removed. The method to be adopted will be: (1) the development of rooms of medium dimensions in a given panel; (2) the establishment of batteries and broken rock at their bottoms to form filters allowing the water to pass, but not the dirt, which will be run in through pipes along an upper gangway, with a pumping of the filtered water; (3) a drying of the filling in the panel, after a varying period of some length; (4) a removal of the original pillars, and filling of the spaces and the gangways, when abandoned, with culm. In this way, by sufficiently developing the lower workings of a mine, we can retreat toward the surface, and remove all the mine contents by the employment of what is now a nuisance.

Another cause of loss in the valuable portions of the banks is the habit of allowing the men who run out the waste during the winter to build fires on the surface to warm themselves. These fires, unless watched, invariably communicate to the interior. Some have been

burning for many years, conclusively showing that not only coal and "culm," but even slate and rock containing small amounts of carbon, will burn, and persistently. It is a common thing to see the present waste run out over a steadily-burning and settling bank, from which abundant fumes of sulphur continually ascend, and whose white and cleanly-burned ashes show the thoroughness of the combustion. These burning banks have been a revelation to some as to methods of burning impure compounds of carbon. Further information in the same line has been derived from study of those portions of mines where underground fires have been finally extinguished. In these, as, for instance, in the celebrated case of the Butler mine, near Pittston, Pa., it has been found that the continuance of the combustion was due to the carbon in the slate and the more porous and worthless portions of the coal, while the solid parts did not burn at all, unless chipped off by the heat and accumulated in small heaps at the bases of the pillars. The slate burned freely, and even at distances from the external air,—for example, throughout the partings in the pillars, and where the only supply of oxygen seems to have been that originally contained in the interstices of the rock. How this fact has been utilized will be shown later.

Careful estimates based on actual workings show that from 40 to 70 per cent. of the culm banks is available as marketable coal. The attention of the trade is directed to them as too valuable sources of heat to be wasted, and it will now be in order to briefly state some of the many ways of utilizing their heat contents. These can be grouped under three general heads:

1. Burning culm in its ordinary state.
2. Reducing to an impalpable powder and burning.
3. Combining with some substance to form briquettes, etc.

Under the first more than fifty patents have been issued; under the second, thirty; under the third, more than a hundred. These show that the subject has excited attention.

The first attempts to burn culm were unsuccessful, because the material experimented upon was too large, and the amount of carbon exposed was slight when compared with the surface of the particles; so that, while culm banks might smoulder for years, their material would not burn in grates, as the ash formed on the outside of the pieces prevented the fire from communicating with the carbonaceous particles in the center rapidly enough to keep the temperature at the point of union of oxygen and carbon. In other words, the fire was chilled. As soon, however, as the attempt was made with small-sized culm, success was attained, as long as the fire was kept at a sufficient depth, and sufficient air was forced through the mass. The furnaces used are of three types,—with fixed, oscillating, and traveling grates. The draught is by steam jet, or by fan.

The fixed grate, consisting of adjustable bars, did not fully succeed, and it was not till Mr. Wootten brought out his perforated plate through which air was forced that burning could be said to be successful. For stationary boilers the work of charging and raking is severe, while for locomotives it requires the greater portion of the time of the fireman, and increases with the poverty of the fuel. If the draught is too strong and the fuel fine, there will be an accumulation at the flue end, which must be frequently removed. The removal of the large amount of ash is difficult with the fixed grate, and on this account the modern types are movable.

The conditions to be filled by such a grate are permanency under exceptionally hard usage; freedom from burning out, and thoroughness and ease in the removal of ash. The best types of oscillating grates rock in such a manner that the fine fuel can not fall into the pit during their rotation, and the ash formed at the bottom of the fire is systematically cut off in sections and dropped into the pit by rotating the bars in one direction, while their reversal breaks up the clinker and renders the bed porous. The advantage of this grate over the traveling type is its greater stability, and freedom from getting out of order,—the latter defect often characterizing the traveling type when old; but the disadvantage (shared by all ordinary types of furnaces) is that combustion is not so perfect as in the traveling grate, the charging of cold fuel upon the partly burned fire always chilling the lower part below the temperature necessary to combustion, causing this part to go into the ash-pit, where it is lost.

Probably the best type of traveling grate was invented by the late Eckley B. Coxe; its prominent features are the freedom of the bars from warping and their ready interchangeability. Traveling grates charge themselves; convey their burden to the place where it is to be burned; keep it there till fully consumed; and remove the ash. When the subject of draught is considered, the Coxe furnace presents another valuable feature.

As before stated, the depth of fire will be found to have a relation to the size of the fragments burned. To fully maintain a fire of large sizes, there must be too thick a bed for ordinary heating purposes. For this reason there has always been a waste in household stoves and furnaces, as the fire has been too thick for the grate area, and a large portion has gone off incompletely consumed; moreover, the thick clinkers are hard to remove, and the loss of good fuel in cleaning grates is considerable, as can be seen by examining the average ash-barrels. The experience of the writer has conclusively shown that fine grate bars and small, and even minute, sizes of coal will become the rule when people are educated to that standard; so that thin fires can

be easily kept alight. With chestnut and pea coal a considerable amount of dirt will make little difference in completeness of combustion, so that, with a good furnace and a minimum draught, a single shovelful of coal every thirty-six hours will support combustion and comfortably warm a house during such chilly days as have occurred in April and May of this year. With furnaces for steam purposes, on the contrary, a forced draught must be maintained. This can be produced by fan or steam. The former produces more complete combustion, but is more destructive to the grate bars; the latter cools the lower portion of the bed, softens the clinker, and prevents burning out of bars. The comparison between the two thus becomes an economic one, and is to be measured by dollars and cents saved during long intervals under as nearly similar conditions as can be obtained. The fan blast is more simple to arrange than that by steam, as steam and air must be fully combined before striking the fire, to prevent cold spots. The best device thus far is the "argand" jet, where steam escapes from a perforated ring of pipe, around and inside which the air enters. The ash-pit must be sealed in all forced draughts, and in the ordinary methods an equal pressure is supplied to all parts of the grate. This is not of much importance in the case of fixed and oscillating grates, if the fuel is evenly distributed; but in the traveling grate it becomes a source of loss, as that portion of the grate leaving the furnace carries almost-consumed fuel, and air sufficient to consume the carbon in the fresh fuel is too much for portions half and wholly consumed, so that through these parts comes a blast which cools the gases of combustion in proportion to their want of carbon. The Coxe furnace avoids this by arranging the ash-pit in compartments and providing each with its amount and strength of blast, so that the highest efficiency is maintained throughout.

The second general division is that in which the fuel is first reduced to an impalpable powder and blown into the combustion chamber. The ideal furnace is one in which the fuel is kept in suspension in the air till entirely consumed, and from whose chimney no smoke issues. All of the original attempts were unsuccessful, and, according to a statement lately made before the Franklin Institute of Philadelphia, the trouble has been in the regularity of feed. In all of these furnaces there must come a preliminary pulverization of fuel, so that they start with an added cost and promise a rapid and complete combustion. Their mechanism must be somewhat complicated and delicate, and the chances of disarrangement must be correspondingly good. At present they are not numerous.

The third general division is that in which culm is combined with some substance, inert or combustible, to form a fuel which will stand

handling, and should resist the weather. As early as 1837 the subject was taken up, and a patent issued. The inert substances used are clay, soap, plaster of paris, hydraulic lime, slacked lime, carbonate of soda, wood ashes, caustic soda, sulphate of ammonia, sulphate of iron, sand, silicate of potash, furnace slag, brown sandstone, geyserite jelly, black oxid of manganese, etc., either alone or combined with others; the combustible substances are legion, the principal ones being bituminous coal slack, asphalt, petroleum, dead oils from distilling the last, and some one of the hydrocarbons. The great objection to the products from any of these is that they do not sufficiently resist crushing, and so can not be stored in large quantities; or they do not resist the weather. The history of the many industries which have started in this country with flaming prospectuses and have gone out of business would fill volumes, and at present there are not half a dozen plants utilizing "culm."

The banks, however, have been attacked in another and entirely different manner,—by treating them as coal sent up from the mine and stocked. A number of "washeries" have been built of moderate height, with bars for separating the rock and allowing the culm to pass through, and go thence to the screens and jigs as in ordinary practice. The results are highly satisfactory, and, in a paper read before the American Institute of Mining Engineers in 1894 by Mr. Arthur W. Sheafer, it was shown that, in the four years between 1889 and 1894, there were shipped from the Stanton bank,

Stove coal,	19,874	tons
Chestnut coal,	31,734	"
Pea coal,	40,283	"
Buckwheat, etc.,	118,478	"
Total,	210,370	"

In this case the product averaged 60 per cent. of the total volume of culm treated. In twenty-five months 120,440 tons of similar sizes were shipped from the Draper bank, which averaged 46 per cent. of the amount treated.

It has been held by the majority of writers that culm banks deteriorate throughout. As to the slate and bony coal, this is true; but not as to the solid benches which have been worked and sent to the dump. As already shown, solid coal will not burn, and still less will its fragments oxidize, as lately shown in some of the coal strippings, where bright crushed anthracite has been sent into the market from immediately under a loose glacial cap of the first and earliest ice advance of the glacial period. The writer has found that the amount of actual rotting of this solid coal has been three-fifths of an inch during these

thousands of years. From this we can see that the solid coal dumped in the culm banks is in nearly its original state at present, and the changes in its character are due to fires and infiltrations of acid waters or stainings with iron. The fact that these old banks are now in active demand, and the further fact that leases are being taken for their reworkal, show that there is good coal in them after their many years of exposure. This seems to be one of the best ways of making culm available; but, as already stated, the finer sizes of coal need not be so thoroughly cleaned for complete combustion as must the larger ones, so that a larger percentage of marketable product will probably be obtained in the future. At any rate, there are fortunes in these old dumps, and they will be used no more for filling till they have been thoroughly reworked.

While this paper was being written, there came the wonderful discovery of Dr. Jacques, by which over eighty per cent. of the energy of the carbon can be obtained directly as electricity without the intervention of machinery, by a method as simple as wonderful. Dynamos will be sent to the attics, and it will be cheaper to heat and work by electricity than by fires. In a series of iron cells Dr. Jacques places caustic soda, which he fuses at 300° F., and in the fused alkali he places rods of carbon. Air being forced through the bath, the combination of carbon and oxygen creates electricity in such quantities that arc lights can be run for hours with little or no consumption of carbon. If this is all that it is claimed to be,—and its sponsors are men who understand what they are saying,—the old culm banks contain reserve energy sufficient to furnish us with power for many generations, and the coal now in the ground will be so mined that culm banks will cease to be the most prominent objects in an old anthracite district.

THE DIRECT PRODUCTION OF ELECTRICITY FROM COAL.

By George Herbert Stockbridge.

TO obtain electricity as a direct result of the consumption of carbon has been one of the perennial problems of the electrical engineer. The history of the art discloses many attempts at its solution, and, as often happens when the answer is elusive and the rewards of success are believed to be large, not a few of the experimenters have been self-deceived. They construct their generating cell with a piece of carbon as one electrode; the galvanometer shows a deflection; what could be plainer? Yet it is most frequently the metallic electrode that is consumed, and we are left little or no wiser respecting the right way to build a carbon furnace for the production of electricity.

Still, there has been enough success in the past to encourage the late-comers, and now, if certain eminent authorities do not err, a true carbon-consuming electrical furnace, showing an efficiency of eighty-five or ninety per cent., has been invented for us by Dr. W. W. Jacques, electrician for the Bell Telephone Company, in Boston. Such an efficiency being greatly in excess of that exhibited by any previous apparatus of the sort, the significance of the new invention is at once apparent. Professor Cross, of the Massachusetts Institute of Technology, and Professor Rowland, of Johns Hopkins, declare it to be one of the great inventions of the nineteenth century, and other high authorities have expressed themselves to the same effect.

The basis of such a startling declaration is not far to seek. An electric generator depending on the consumption of coal and exhibiting an efficiency of, say, eighty-five per cent. would be nothing less than revolutionary in its effect upon the electrical and mechanical industries. To go further and develop the consideration of its effects upon the general advancement of civilization would lead us too far afield for the purposes of the present paper. One need only recall what electricity has already done for the present century to realize that the cheapening of its production might open up still other channels for its application to man's needs or to the advancement of his material and moral interests. I let the "moral" stand, for, though the setting forth of the value of invention as a moral agent is as yet an unwritten, or, at least, an inadequately written, chapter, yet no one that has lived through even a small portion of our later electrical his-

tory can fail to understand that the world is not simply more comfortable, but *better*, by virtue of the telegraph, the railway, and all the rest of the list.

However, to return to the particular case in hand, we have to reflect that the best result obtainable in producing the electric current by the employment of the steam engine operating a dynamo electric machine is not above seventeen to eighteen per cent. under the best possible conditions. The most improved triple-expansion engines have a thermo-dynamic efficiency not exceeding nineteen per cent. Granting to an efficient dynamo the capacity for converting into electrical energy about nine-tenths of the energy with which it is supplied, we get about the maximum figures above-mentioned. In actual practice ten per cent. represents a good result.

It is natural that, with so small returns coming from the indirect conversion of carbon energy into electrical energy, inventors should have looked for vastly greater results from more direct methods. Instead of heat, power, and electric current, with the inevitable losses at every transformation, why not consume the carbon, and get the current from such consumption without the intermediate steps? The theoretical advantages have long been appreciated. The practical attainment of them in a high degree seems not impossible. In any case, the significance of eighty-five or ninety per cent. efficiency for the Jacques generating cell as compared with seventeen or eighteen per cent. for the steam engine and the dynamo is plain at the outset.

In candor, it must be said that the efficiency noted for the Jacques apparatus is the efficiency of the generating cell (which will be described later), irrespective of the expenditure of heat for maintaining the cell at a suitable temperature, and of power in running the air-pump which supplies it with oxygen. In the absence of data on these points, the only thing that remains is to compare the Jacques apparatus with other direct producers of electricity from carbon, rather than with the combined steam engine and dynamo. I have already alluded to the activity in this line of invention. It now appears likely that Dr. Jacques's idea will be the subject of rival claims, and, to say truth, the earlier investigators were surprisingly near the road to complete success, however far away they may have been in the results actually obtained.

As early as 1855, Becquerel discovered that he could produce a current of electricity by burning carbon in contact with an electrolyte capable of supplying it with oxygen. His apparatus consisted of a platinum crucible containing molten nitrate of potash, into which he plunged a carbon rod glowing at its tip. The carbon was still further consumed with a resultant generation of electric current.

Better known are the experiments of Jablochkoff, who, in 1877, patented a process of generating electricity by the action upon carbon of a solid electrolyte in a state of fusion. Jablochkoff, like Becquerel, employed one or the other of the nitrates, but preferred the nitrate of soda by reason of its cheapness. For the metallic electrode Jablochkoff suggested platinum, or some other metal not acted on by the liquid in the presence of carbon. Jablochkoff's invention became the starting-point for the work of a number of inventors, who contented themselves with improving his process or the apparatus by means of which it was carried out. Even when improvements in other particulars had come in, the employment of the molten nitrates was long continued,—partly by reason of their cheapness and general availability, and partly, it is fair to assume, by reason of Jablochkoff's authority.

Later we begin to find suggestions for reviving the exhausted electrolyte by the action of atmospheric air, and even for injecting air by artificial means into the reduced liquid. As this constitutes one of the leading features of the latest improvements in the art, to which we are presently coming, it will be worth while to review for a moment what has been done along this line of progress.

One of the first to suggest the use of a current of air as a "depolarizer" was J. Hubert Davies, in 1882. Into a cell made up of molten nitrate of potash, carbon, and some metal such as iron, tin, platinum, silver, or copper, Davies passes nitric acid fumes by means of air, or he passes air alone into the molten nitrate. In place of potassium nitrate, Davies suggests as practicable substitutes monoxid or dioxid of barium, nitrate of barium, one or other of the oxids of lead, lead nitrate, cupric nitrate, and borax either melted by heat or moistened by a liquid. Concerning this cell an affidavit has been made by Mr. Charles A. Stone, pointing out that, in an actual test, the metal was consumed, and that, when heat was applied gradually, a current was produced representing less than one per cent. of the potential energy of the carbon. Substantially the same statements are made by Professor Goodwin in an affidavit.

A year after Davies, Mr. Alexander Melville Clark conceived the idea of "fixing the oxygen of the air in a substance susceptible of forming a liquid combination, and then expending this oxygen to produce electricity by the oxidation of a suitable substance (generally carbon), and lastly reoxidizing by the oxygen of the air the substance which serves as the vehicle." In reducing his conception to practice, Clark makes use of potash, or soda, or both, in a state of fusion, puts the molten nitrate into a copper vessel, and plunges into the liquid a piece of carbon. Thus much is clear. But the process, as a whole, is obscure, and some of Clark's directions are either misleading

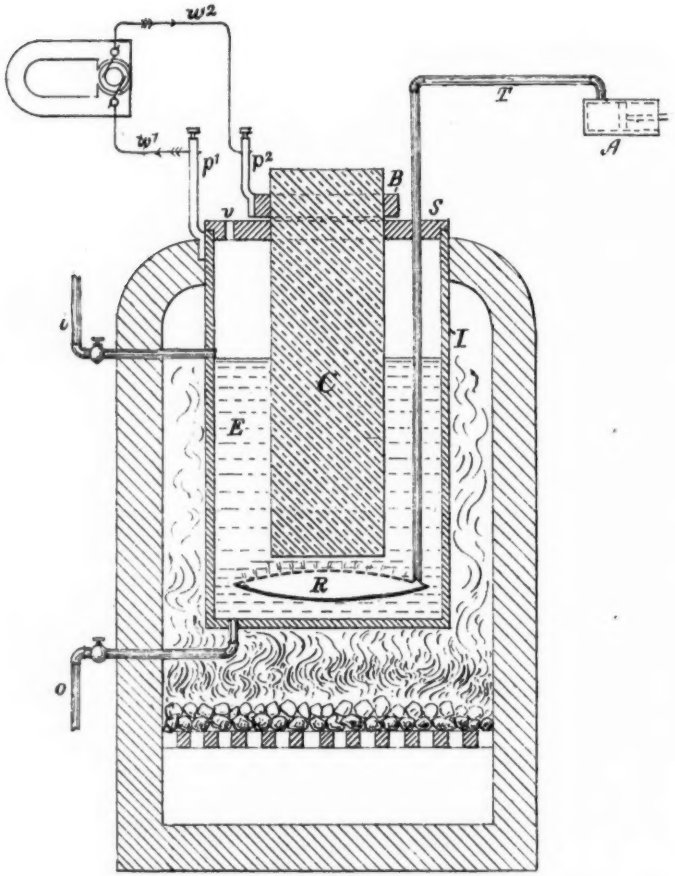
or difficult to understand. According to the statements of Mr. Stone and Professor Goodwin, the current generated in a Clark cell constructed as nearly as possible by his directions is very feeble, while the copper vessel is so manifestly consumed as to coat the carbon electrode. Professor Rowland confirms these statements, and further declares that there is, in fact, no regeneration of the electrolyte as described in Clark's specification.

In 1890 Henry Gilbault proposed the substitution for Jablochkoff's nitrates of some cheaper substance reducible by the carbon, but capable of being regenerated by heat in contact with air. Gilbault conceived that it would thus be possible to prevent the reduction of the molten electrolyte by directing upon its surface or through its interior an air current. The function of the air current was to burn the carbon with an accompanying release of electrical energy. It does not appear how far Gilbault went toward perfecting his process of electrical generation.

Other inventors followed in the footsteps of Davies, whose invention Professor Rowland declares to be inoperative, because he uses nitrate of potash or some equally inadequate substitute.

This being the state of the prior art, we come now to the work of Dr. Jacques, the fortunate discoverer of a more successful and significant method of converting the potential energy of carbon into electrical energy. Dr. Jacques began his investigations some five or six years ago, and in 1891 he prosecuted a series of experiments which demonstrated the practicability of his electric furnace. By Dr. Jacques's own account, his invention is based on the discovery "that, if oxygen, whether pure or diluted, as in air, be caused to combine with carbon or carbonaceous materials, not directly, as in the case of combustion, but through an intervening electrolyte, the potential energy of the carbon may be converted directly into electrical energy, instead of into heat." Practically, Dr. Jacques supplies the active or oxidizing element of his generating cell with an excess of oxygen by means of an artificial air-blast. The electrolyte, whose first action after the cell is set up is to release its oxygen and so permit it to attack the carbon, is thus continuously renewed by fresh charges of oxygen, which are at once carried to the carbon for a continued attack. The carbon is consumed, and electrical energy is developed in a corresponding degree, the rate of consumption and the strength of the electric current being gaged by the rapidity with which air is supplied to the electrolytic compound.

The generating apparatus described by Jacques, and illustrated in the accompanying cut, consists of a pot of pure iron surrounded by a suitable furnace and containing caustic soda (sodium hydrate), into which extends a rod or cylinder of carbon. Naturally the carbon



DR. JACQUES'S GENERATING CELL.

From the Patent Drawings.

I is the iron pot, E the melted caustic soda contained in it : C is the carbon prism, R the rose through which air is blown into the caustic soda from the air compressor, A. p^1 and p^2 are the poles between which the electric current flows.

must be in such a state that it may serve as a good electrical conductor. Gas carbon and charcoal are available without special treatment, but anthracite coal has to be baked to give it the requisite conductivity, and bituminous coal needs, for the same purpose, to have some

of its hydrocarbons driven off. Commercial caustic soda can be used without expelling the usual impurities.

In addition to the foregoing elements of the generator, Jacques provides an air-pump for forcing into the sodium hydrate an excess of oxygen, the air containing the oxygen being carried to a "rose" for distributing the air currents through the electrolyte in fine sprays. The rose is made of a metal not acted upon by the hydrate. The whole being supplied with a suitable insulating cover having a proper vent, the apparatus can be set in operation by bringing the furnace and its inclosed generator and electrolyte to a temperature of 400° to 500° Centigrade, and operating the air pump. By virtue of the violent ebullition caused by the jets of air, every part of the electrolyte is brought into contact with the air, from which it takes up oxygen in excess; after which it is carried against the carbon, and releases the oxygen collected in its travels. The carbon is attacked by the oxygen, and suffers a gradual consumption as long as the operation continues.

It is found that the electrolyte needs renewing at intervals, by reason of its slow contamination by carbonate of soda, resulting from the union of some of the caustic soda with carbonic acid developed in the generating process or coming from the injected air. Moreover, the ash from the carbon tends to lessen the efficiency of the electrolyte. But, if a small percentage of oxid of magnesium be added to the electrolyte, its renewal may be sensibly postponed. According to Dr. Jacques, the oxid of magnesium serves as a carrier to convey the carbonic acid through the electrolyte. His conception of the action of the oxid of magnesium is that the free carbonic acid combines with it in preference to the caustic soda, and that the carbonate of magnesium so formed is quickly decomposed into carbonic acid, which escapes, and oxid of magnesium, which is again ready to repeat its action. In any case, that part of the carbonic acid which causes contamination is very small, the most of it bubbling up through the caustic soda and escaping into the air.

Respecting the oxidizing agent, Dr. Jacques says: "There are many electrolytes that may be used in practising my invention. Following are some of the desirable characteristics. They should become liquid at a convenient temperature. They should possess good electrolytic conductivity. They should be capable of readily taking up oxygen from the air or other source of supply, and also capable of readily giving up oxygen into combination with the carbon. They should not have a strong affinity for carbonic acid, and, in case air is used as a source of oxygen supply, should not have any considerable affinity for the nitrogen or other substances with which the oxygen of the air is diluted. The molten hydrates of potash and soda are espe-

cially suitable for practical use." The use of pure iron for the collecting electrode is recommended as generally applicable and inexpensive; but steel and iron containing a considerable amount of carbon are to be avoided. The sodium hydrate, when melted, has no sensible chemical action upon the iron, which, therefore, remains substantially unchanged.

Briefly, the process employed by Jacques consists in chemically combining oxygen with carbon by impregnating a molten basic electrolyte, which is in contact with the carbon, with oxygen or air, and collecting the electricity thereby developed by means of an electrode not acted on by the impregnated electrolyte when the circuit is completed. To render the process continuous, a sufficient heat is maintained by means of a suitable furnace, and the air-pump is kept in operation. Incidentally, the bubbling of the air through the heated electrolytic compound contributes to securing and preserving a uniformly-distributed heat, which is, of course, to be desired.

In the choice of the hydrate of sodium or potassium as an element of his generating cell, Jacques has been particularly fortunate, while, no doubt, the general adaptation of his apparatus to a clearly-defined purpose has been of great value and importance. The employment of a pure iron electrode is another fortunate detail. In a word, Dr. Jacques has disclosed an apt invention, based on a well-conceived theory of the nature of the problem alluded to at the outset of the present article. He has made clear, and possible of practice by every one skilled in the art, the notion which Clark seems to have entertained, without, however, adequately describing a working process or a working apparatus. The efficiency of eighty-five to ninety per cent. claimed for the Jacques apparatus is vouched for by distinguished electricians, who, as stated, also comment on the broad significance of the results obtained. Whether or not his experiments have achieved what can immediately be turned to commercial use it is, perhaps, too early to say; but at least he is to be congratulated on having revived the waning hopes of the scientific world respecting a hitherto disappointing search for an efficient carbon-consuming electrical furnace. Future investigations in this field are pretty sure to follow Dr. Jacques's lead.

It has been reported recently that, with a Jacques battery of 100 iron pots, 12 inches deep and 1½ inches in diameter, a current was obtained averaging 90 volts and 16 amperes and supporting thirty 16-candle power incandescent lamps for nearly 19 hours. In this test about 8 pounds of carbon were consumed in the pot. If the consumption taking place in the pot were all that is to be taken into the account, this result, representing an efficiency of about ninety-four

per cent., would be of enormous interest and value. Unfortunately, we are not told how much coal it took to run the furnace and the air-pump.

In the present state of the investigation, this exclusive insistence upon the story of the generating cell seems not unfair. The great thing to prove was that an attack by oxygen upon carbon could be made effective under *any* conditions for producing current with good efficiency. If it should appear that the production can take place only in the presence of heat, or that, as one critic has asserted, the Jacques organization is nothing more than a good thermo-electric battery, the rejoicing over Dr. Jacques's work will be considerably tempered. Till that be definitely settled we may withhold our final judgment.

Dr. Jacques is a graduate of the Massachusetts Institute of Technology (1876) and of Johns Hopkins (1880). For a number of years he has been located in Boston as electrician for the American Bell Telephone Company.

RECENT IMPROVEMENTS IN GOLD MILLING.

By H. M. Chance.

THE article in the June number of THE ENGINEERING MAGAZINE sketched the extent to which the increased activity, profit, and production in gold milling was due to improved machinery and methods in use for mining, crushing, and amalgamating free-milling ores; but the progress does not stop there.

The treatment of partially free-milling and refractory ores has been bettered and cheapened by improved concentrating, extracting, and smelting methods and appliances. It is not intended to enter upon a discussion of smelting methods and appliances, as the present article proposes to deal only with those processes for the direct extraction of gold which are carried on in connection with, or as a part of, the milling plant, and which, like the chlorination and cyanid processes, are now successfully operated on a large scale.

In selecting the proper treatment for any partially free-milling ore, the first step is to determine by amalgamating tests what values per ton can be recovered by plain amalgamation when crushing to mesh of different sizes. It may happen that a very small part of the yield can be so obtained, and perhaps this may require very fine crushing with large production of slimes, which will complicate concentration and subsequent treatment. In such cases better results may be had by concentrating without amalgamation, or by concentrating, and then re-crushing and amalgamating the tailings, or, if the gold occurs in very fine particles, possibly by subjecting the ore to chlorination or cyaniding direct, or by concentrating and then cyaniding the tailings. In a majority of cases, success or failure depends upon the proper solution of this problem, the cheapening and improvements effected in treating such ores having been accomplished by working out methods rationally conforming to the peculiarities of each ore rather than by attempting to force the ore to yield to any predetermined process.

Recent improvements in concentrating appliances, in vanners, bumping tables, and slime tables, are confined to details of construction, which, while reducing their first cost and cost of maintenance and increasing their capacity, have not greatly increased their efficiency, for these machines, as built for many years, have been constructed on the same principles and have been capable of performing satisfactory work. The same statement applies equally well to jigs used for concentrating coarser material.

Until recently few mills were supplied with concentrators of suffi-

cient capacity to properly handle the pulp, and some mills are yet equipped with ridiculously small concentrating plants. The writer has seen plants arranged to run from forty to eighty tons of pulp daily over a single vanner. Such instances, however, are becoming rare, the present tendency being to equip every plant with concentrators of ample capacity, though the fact is recognized that there is a limit at which the increased cost of concentration, wear and tear, etc., becomes equal to the value of the increased quantity of concentrates saved, and that the maximum profit will be found at some point inside this limit.

While the chlorination of refractory gold ores is not a recent invention, chlorination methods and appliances have been entirely remodeled within the last few years. First of all, and perhaps of as great importance as any other step in the process, is the improvement in roasting methods brought about by the elimination of many complicated, unsuccessful, or expensive roasting furnaces, and the survival and adoption of the simpler and better forms. The Bruckner or cylinder style roaster, and the ordinary reverberatory and revolving-pan roasters, are now thoroughly understood, and their possibilities and cost of operation have been established by long use at many plants. Some of the many forms of shelf roasters and of machine rabblers seemed destined to effect further economies, and it is probable that they will soon be more favorably received.

In the same way many chlorination methods have been tried and abandoned, and from this experimental work the simple and efficient apparatus and modes of applying the process now in use have been developed and perfected.

In working ordinary pyritic ore or pyritic concentrates present practice aims first at securing as nearly a "dead" roast as possible,—that is, to reduce the percentage of sulphur to the smallest possible quantity, which usually means to less than one per cent. and sometimes to less than one-quarter of one per cent.

The use of salt in roasting auriferous pyrites for chlorination is by no means so general as in earlier practice,—often being found unnecessary,—and, when used, it is now added in the smallest possible quantities and near the end of the roast. The loss of gold in chloridizing roasting has been reduced, but not eliminated, although, in some cases, it is claimed that, by adding the salt when the roasting is nearly complete and withdrawing the charge without attempting to make a close roast, the loss is insignificant, and the recovery by subsequent treatment satisfactory.

To Mr. A. Theis perhaps more than to any other single worker in this field is due the present admirable combination of methods, appa-

ratus, and appliances which in the last few years have so greatly cheapened and simplified the process. His work has been marked by the development of a chemical process, formerly difficult, uncertain, cumbersome, and expensive to work, into one so simple and sure that it can be operated almost entirely with unskilled labor. The cost of treatment has thus been reduced from eight or twelve dollars per ton to from three to six dollars per ton of material treated, the lower figure applying to operations on a large scale or where cheap labor (as in the south) is available.

As this cost in most cases applies not to the whole quantity of ore, but to the concentrates only, which commonly range from three to fifteen per cent. of the ore milled, the cost of chlorination may be taken as ranging from twenty cents to one dollar per ton of ore mined. Hence it is evident that nearly all free-milling ores containing gold not recoverable by amalgamation, but which can be saved in concentrates suitable for chlorination, should be so treated, for there are few ores indeed from which the concentrates will not show value sufficient to repay with profit the cost of concentration and chlorination.

The principal item of cost in treatment by chlorination is the preliminary roasting of the ore or concentrates, which may amount to more than one-half of the total cost; excluding this, the cost of the process falls to three dollars or less per ton.

Direct chlorination—*i. e.*, chlorination of the ore without previous amalgamation or concentration—is a recent and promising extension to the process. It cannot, of course, be applied to ores containing coarse particles of gold, but there are numerous deposits to which it is adapted and on which it may now profitably be operated.

Dry crushing, by crushers and rolls, is the style of milling most popular at the present time for preparing such ores for treatment. A fair percentage of extraction has been obtained in many cases by comparatively coarse crushing, and it is claimed that the chlorine solution has considerable penetrative power, and that in a moderately short time it will dissolve the gold from coarse particles,—say from ¼- or ½-inch fragments. It is also claimed that cyanid solutions act in the same way; while this may be true of its action on some ores, it may be necessary to modify these claims, if it be found that the gold in such ores is confined to the softer portions of the ore, the larger fragments (harder portions) of the gangue being lean or barren. However this may be, a good percentage of extraction is obtained from some ores both by chlorination and by cyaniding, without crushing to fine mesh.

The most generally approved method of operating the process is by chlorination in batches, with bleaching powder and sulphuric acid,

in revolving barrels, discharging the pulp on filters where it is filtered and washed by gravity or pressure, and precipitating the gold by H_2S (sulphuretted hydrogen) or $FeSO_4$ (ferrous sulphate, copperas); or by filtering through charcoal, the precipitate being allowed to settle, the clear water drawn off, and the precipitate dried in a filter-press or evaporating pan. This is substantially the process so successfully elaborated by Mr. Theis for working pyritic concentrates at the Haile Mine, S. C., and Mr. J. E. Rothwell for working refractory ores in bulk at the Golden Reward Chlorination Works at Deadwood, S. Dak.

At present chlorination is successfully used in treating a larger variety of gold ores than are treated by any other process. The manufacture and sale of condensed chlorine, at reasonably low price, promise to further cheapen the process, especially at many more or less inaccessible localities, where the cost of transportation of the sulphuric acid and bleaching powder used forms a considerable part of the total cost of treatment.

Bromination appears chemically similar to chlorination, but its possibilities, peculiarities, and limitations are not yet fully known. Much that is claimed for it just now may not be realized in practice, but the testimony of those who have experimented with it is, in the main, favorable, and there is reason to believe that it may prove a valuable adjunct to chlorination, and may possibly succeed on some ores not suited to that process. The present cost of bromine is the greatest obstacle to an extensive application of the process; but this difficulty will disappear, if it be found that very dilute solutions can be used, or if some cheap and simple method of recovery be devised.

The cyanid process, known also as the McArthur-Forrest process, which consists in dissolving the gold from ore, concentrates, or tailings by leaching (or agitation) with a dilute solution of cyanid of potassium and precipitating the gold with metallic zinc, has now been in successful use since 1890. It was at first received with the skepticism usually accorded a new process, but its phenomenal success in treating tailings in South Africa soon demonstrated its value. In 1891 it was first successfully applied to treating ore in bulk, at the Mercur Mine, in Utah, and the cost of treatment was shown to be so low ($2.40 per ton) that its future seemed assured. Its use has not, however, extended in this country as rapidly as in Africa, owing doubtless to some failures here from attempting to work ores to which it is not suited. Like all other processes, this process has its limitations: (1) it does not work successfully on raw ores in which the gold exists chemically combined with some other element or elements, as in the Cripple Creek district; (2) when the gold is intimately associated with cop-

per, antimony, and arsenic minerals; (3) when the ore contains acid salts resulting from the decomposition of pyritic minerals, the consumption of cyanid often being so large as to be prohibitory.

The cost of treatment necessarily varies with the consumption of cyanid, which may be large or small, depending upon the presence of minerals which destroy or combine with it, ranging from less than one pound of cyanid per ton of material treated to several pounds per ton. When such minerals are present in quantity, it has been found possible in some cases to reduce the loss of cyanid by working with extremely dilute solutions (1/10 to 1/4 of one per cent.), cyanid being added at intervals to replace that destroyed or absorbed, thus maintaining the normal strength of solution.

The labor cost of the process varies with the design, capacity, arrangement, and mode of operating the plant. At some of the more recently designed plants it should not exceed twenty-five cents per ton.

After the solution has filtered through the ore, it is passed slowly through boxes or troughs filled with zinc shavings, which precipitate the gold, the solution then passing to storage-vats, where it is reinforced with sufficient cyanid to bring it up to normal strength.

The Siemens and Halske electrolytic method of deposition is better adapted to some ores than precipitation by zinc. It is effected by passing the gold-bearing cyanid solution slowly through vats or troughs filled with alternating anode (iron) and cathode (lead) plates, which are allowed to remain undisturbed for several weeks or months, when the cathodes, heavily plated with gold, are removed, melted, and cupelled. About 8,000 square feet of cathode surface is required to electrolyze 100 tons of solution in 24 hours. The consumption of current is small, 4 or 5 electric h. p. sufficing to run a large plant.

The cost of operating the cyanid process in Africa has steadily fallen, and it is claimed that tailings have actually been worked by it at a cost of 56 cents per ton. Whether such low cost be possible at other works may be doubted, but it is now well established that, under widely-varying conditions, work has steadily been carried on at costs ranging from $1.80 or $1.90 per ton down to $1.00 or less, and improvements under way will still further reduce these figures.

The example set by the Mercur Mine is being followed at one mine at least in South Africa, where the direct treatment of the ore in bulk has been accomplished at a reported gross cost of $2.50 per ton for milling and cyaniding. The growth of the process in this country, as applied to the direct treatment of ore in bulk, dates from its adoption at the Mercur Mine in the fall of 1891, with a capacity of 50 tons daily, which was enlarged to 200 tons, and is now being increased to 400 tons. In 1892 and 1894 two plants were started in-

Montana and Utah; in 1895 six plants were installed in Colorado, Utah, and Oregon, with aggregate capacity of 380 tons daily; and one of these is now being enlarged by 150 tons, while two other plants in Colorado and Utah are being constructed.

As applied to the treatment of tailings in this country, the record compiled by the Gold and Silver Extraction Co., Limited, shows that four works, with a capacity of 146 tons, were installed in 1893, three works, to treat 116 tons daily, in 1894, and six plants, with an aggregate daily capacity of 410 tons, in 1895.

"Pyritic smelting" is another process which may properly be discussed as an adjunct to gold milling proper. It is applied to smelting heavy sulphid ores or concentrates only, and is carried no further than necessary to produce a rich matte, in which the gold contents of two, three, four, or more tons of material are concentrated into one ton of matte, which is shipped or sold to smelting or refining works for further treatment. In this process the heat developed by the combustion of the sulphur contained in the ore is relied upon to effect the smelting, fuel being used only to light the charge, after which the ore may be said to smelt itself. The process is of recent development, but enough has been done to prove its value for treating heavy pyritic ores at points distant from smelting centers.

Gold ores not adapted to free milling, chlorination, bromination, cyaniding, or pyritic smelting are at present reduced by smelting. A number of wet processes for treating certain classes of ore now going to smelters are being exploited, and doubtless some of them will prove valuable. Never before in the history of gold-mining have so many able, cultivated, and well-trained brains been working upon this problem; never before, therefore, has there been the same reason to anticipate the invention of new or improved processes.

All of the approved methods in use, when applied to ores to which they are suited, yield a satisfactory percentage of extraction. On strictly free milling propositions, it is not unusual to recover from eighty to ninety per cent. of the total free-milling contents; and, with the appliances in use, the extraction might often be run up to ninety-five per cent.; but this result would be attained at so largely increased cost as to be undesirable. The appliances used in concentration are capable of recovering a high percentage of the sulphids; and the chlorination and cyanid processes yield very high percentages of extraction. Arguing from these facts, it is often claimed that there is no room for further improvement. Precisely the same reasoning might have been advanced twenty or thirty years ago; the Mexican to day is entitled to and does make the same claims for the processes used on silver ores one hundred years ago. That existing processes and appli-

ances are efficient, and that the possible increase in efficiency is limited, must be conceded; but it is true, nevertheless, that the field for improvement is as wide as ever, provided the aim be to find cheaper (and possibly simpler) processes and appliances, to increase capacity, and to attain efficient working at lower cost.

The possibility of enlarged profits from increased efficiency alone is limited, for a perfect process could increase the yield only from fifteen to twenty-five per cent. over that attained by the processes in use; but the possibility of enlarged profits from the combined effect of reduced working cost and increased efficiency is not arbitrarily limited to any percentage.

Improvements might be noted in rolls, mills of the Huntingdon type, ball mills, bumping tables, jigs, hydraulic classifiers, amalgamating and clean-up pans, canvas planes, and many other useful appliances, and in many of the new (and old) special processes; but so extended a discussion of the subject is beyond the limits of this article.

Mining is popularly considered more hazardous than other productive industries, because it is admittedly impossible to look into the earth and determine, in advance of actual developments, how far the character, thickness, and quality of any mineral deposit extend beyond or beneath the face in sight. But other productive industries involve like uncertainties; it is equally impossible to look into the future and determine whether the price, demand, cost, and salableness of any product will increase, diminish, or fail. This uncertainty often may be greater than the risks involved in mining, for it is always possible to so explore and develop any mineral deposit, in advance of actual working, as to expose to sight, or to prove the presence of, sufficient ore, before making a large investment. This is now invariably done by those who engage in mining in a conservative way.

An appreciation of these possibilities is rapidly raising gold mining from the level of speculation to that of legitimate industry, and with this change has come that careful attention to small economies and to minor improvements in methods and appliances which marks all sound industrial operations. From being one of the most hazardous industries, mining thus at once become one of the safest possible pursuits.

As indicating this change in sentiment, it may be noted that established dividend-paying gold stocks four or five years ago might be bought at prices netting the investor from twenty-five to thirty per cent., but at the present time these same stocks command prices at which the investor realizes only ten or fifteen per cent.; which indicates that in the opinion of those investing in these securities, the business is no more hazardous than any industrial pursuit.

MODERN MACHINE-SHOP ECONOMICS.

By Horace L. Arnold.

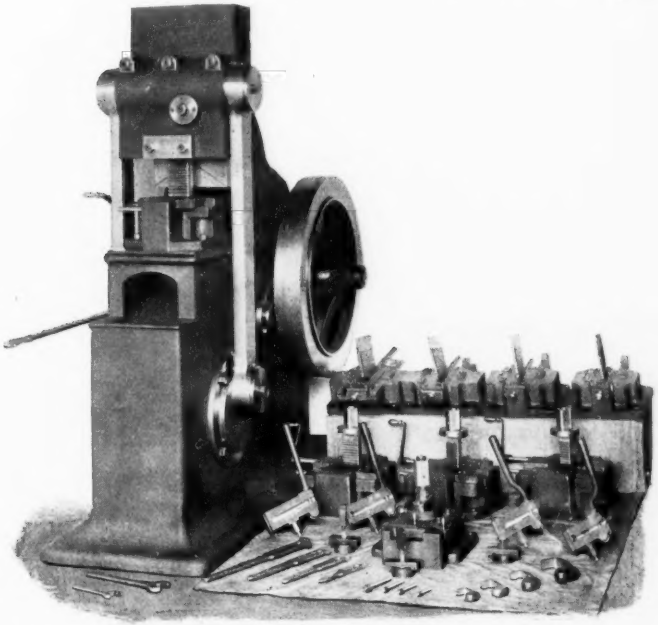
IV.—THE IMPORTANT PROBLEM OF TOOL EQUIPMENT.

NO engineer or superintendent should trust to his own knowledge or past experience in the use of tools as a guide in making extensive purchases of new plant, without first correcting his own conclusions by a careful and extended observation of recent installments in similar lines. The successful engineer of to-day must, it is true, be conservative, for the bold seeker after new and great things may win admiration and respect, but can seldom command confidence ; his failures meet instant condemnation, while his successes require years of use before they can be minted with the stamp of popular approval ; the consulting engineer and the successful superintendent must be conservative, but none the less is it the duty and the province of each to inform himself of the latest successful practice, and to remember always that no one shop and no one man's experience can ever include the best of everything. It would be unwise to equip a new establishment with untried makes of tools, no matter how great the promised gains in efficiency ; but it is surely a greater folly to buy machine tools to-day because they were regarded as first in their class a few years since. There are many old shops in this country struggling against the certainty of failure ensured by the retention of old tools, once the pride of the establishment, carefully preserved, still perhaps almost as efficient as they ever were, but which should be instantly dismembered and go to the scrap-heap and the cupola. Yet it was thought, when those old tools were purchased, that they were not only as good as ever had been made, but that they were as good as ever would be made ; and the purchaser who buys tools to-day without the knowledge which can be gained only by a personal inspection of the latest productions does so at the risk inseparable from all the ventures of ignorance. See what is in use, buy what is most efficient, no matter where or by whom the tool is built.

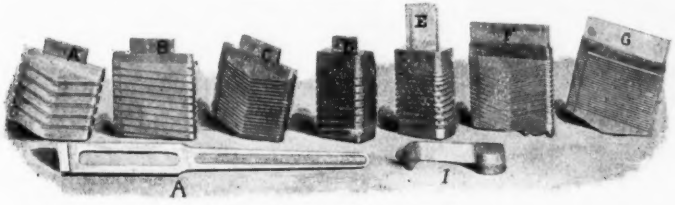
In other directions than machine-tool equipment it is possible to closely define some of the features of real economy.

Up to a comparatively recent date American machine-tool designers regarded grey iron as a precious metal, to be saved and spared by all possible expedients. In the case of some tools—iron planers and boring mills, for instance—that day has gone. The value of mass is understood, and our planers and boring mills are as heavy as they need to be. In the points of easy handling and au-

tomatic movement, American tools have always stood in the front rank. American mechanics shun a tool which does not handle freely, and our engine lathes have probably been less efficient than economy demands, because of our adherence to the V-ways on which our lathe carriages travel. Up to 24″ swing our lathes are now being made effective. Over that size, we have in some cases, possibly, yet to adopt such details as will give our engine lathes the most economical service-possibilities. Our smaller sizes of lathes have been copied exactly by large European makers, who at first failed to equal our product, but now make work fully up to American standards. In milling machines we have always been leaders, and the value of the "Traversing Mill"—a powerfully-driven spindle having a large rise and fall on a heavy pillar which is either made to traverse on a large T-slotted finished sole plate, or is served by a large traversing table—is so well understood that this tool is now made a regular feature of heavy plant installment. As to the economic value of largely increasing the dimensions of the ordinary form of milling machine, there is still a question. Some very large milling machines have been built, but none of these machines have so far proved able to perform the prodigies of rapid metal finishing which, it seems, might reasonably be expected from them, and at this time a feeling of uncertainty is evident among the builders of very large milling machines. It seems highly probable that the past failures to reach the expected production have been due solely to weakness of the milling-machine frame and mill arbor, and the absurdly under-powered drive which has hitherto been furnished. The lathe and planer employ at the most only four or five tools cutting simultaneously; the milling machine may have forty or fifty tools in cut at the same time; the lathe and planer tools can be and are ground individually to the best possible shape for cutting; it therefore seems a perfectly demonstrated proposition that a milling-machine frame and mill arbor should be many times as heavy and stiff as the lathe or planer of the same surface capacity. Yet it is true that no milling machine has yet been offered which was much heavier in framing than lathes and planers dealing with surfaces of equal extent. Again, in the matter of power, a late large cylinder-boring machine, using four cutters in the boring-bar head, took all the power that could be transmitted by a good vertical double leather belt 5″ wide running 1132 feet per minute to cut over a surface 100″ diameter × 5⅛″ wide,—say, 200 square inches in 1¾ minutes, or say 114 square inches of cast iron surfaced per minute by an expenditure of possibly eight horse power, spur gear reduction. The action of the tools in the cutter head of a boring machine is almost exactly the same as that of mill teeth milling a flat surface. Hence it would appear that a milling machine, expected to surface a

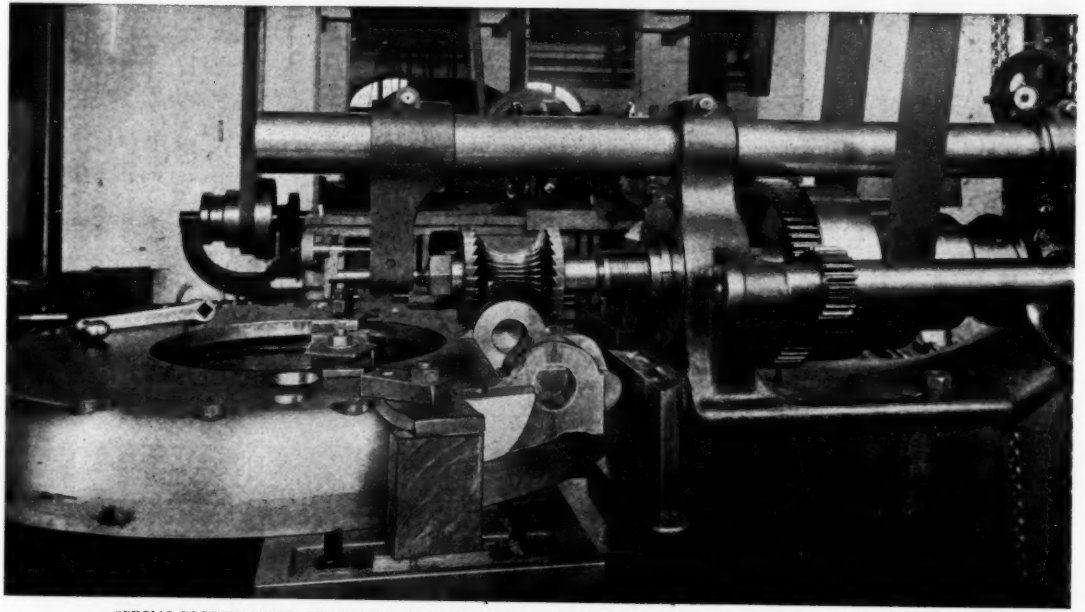


FINISHING BY BROACHING INSTEAD OF MILLING, PRATT & WHITNEY MACHINE, BROWN & SHARPE TOOLS.



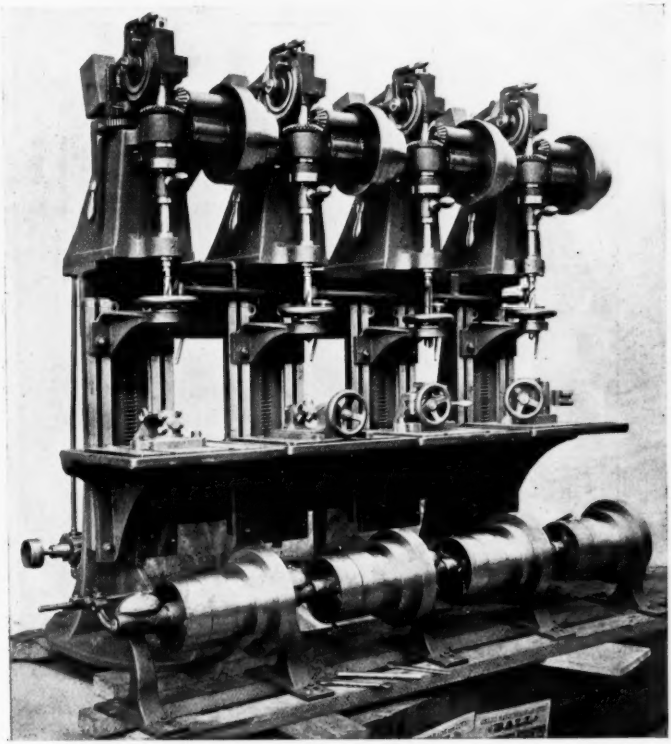
SOME OF THE BROACHES USED.

width of 30″ at the rate of 10″ feed,—300 square inches of cast iron finished per minute,—should have a drive capable of transmitting 20 or 30 h. p. easily, which has not yet been given in any milling machine brought to public notice. It is probable that all the mysteries of mill cuts will disappear, when milling machines are made as heavy, and driven as strongly in proportion to expected production, as other metal-cutting tools. In drilling there has been lately, under the forced production demand made upon the bicycle factories, an enormous increase in

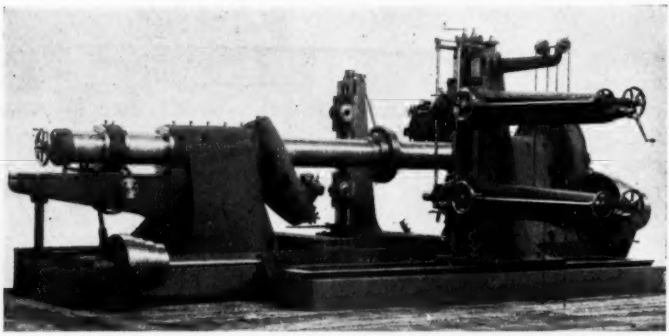


SPECIAL BREECH-COVER HINGE-MILLING MACHINE, WATERVLIET ARSENAL. BY PEDRICK & AYER, PHILA., PA.

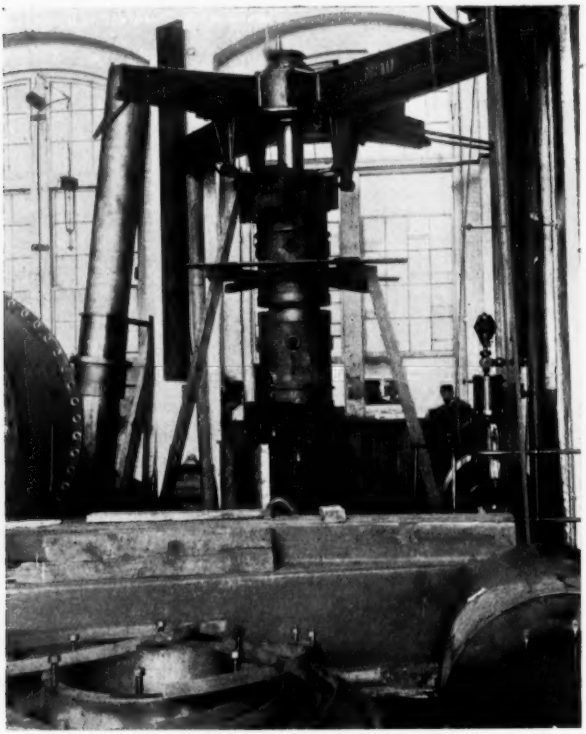
drill speeds, and a very great increase in drill feeds ; the increased speed has been accompanied by a somewhat diminished chip thickness, but the effectiveness of the drill has been fully doubled within a short time, and the practice of "banking" drilling machines—that is, placing them closely in rows, so that one man can attend a number of machines—has reduced the cost of drilling, where the operation is continual, to a very small fraction of what would have been held as good machine-shop practice a few years since. The purchaser who is not fully informed as to the practice of the bicycle factories is more likely to buy under-powered drillers than any other machine tool. A drill feed of 1″ per minute with a $1\frac{5}{16}$″ drill in steel forgings is something so far be-



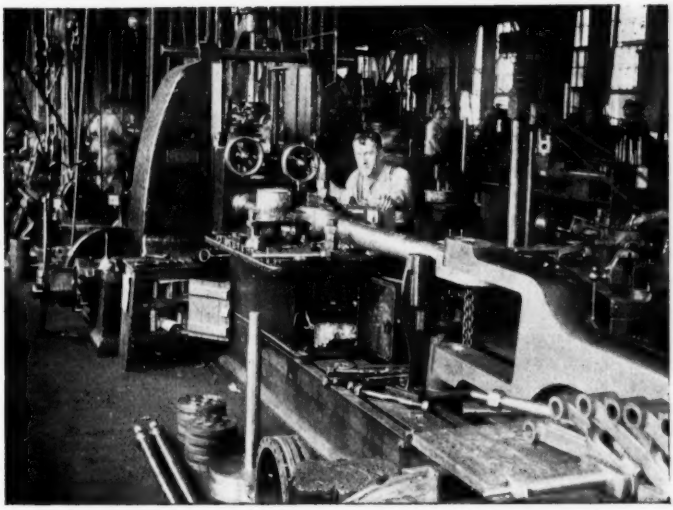
BANKED DRILLERS. BY BAKER BROS., TOLEDO, OHIO. CAPABLE OF DRILLING 1″ PER MINUTE, $1\frac{5}{16}$ HOLE.



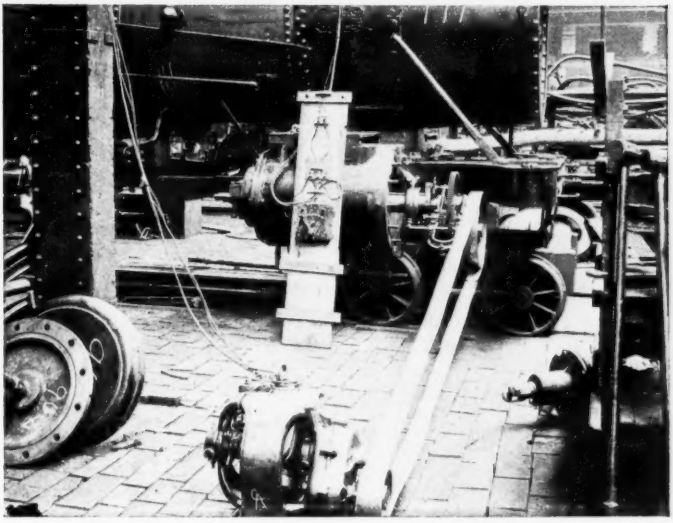
NILES SPECIAL CORLISS CYLINDER-BORING MACHINE, WITH 3 BORING SPINDLES.



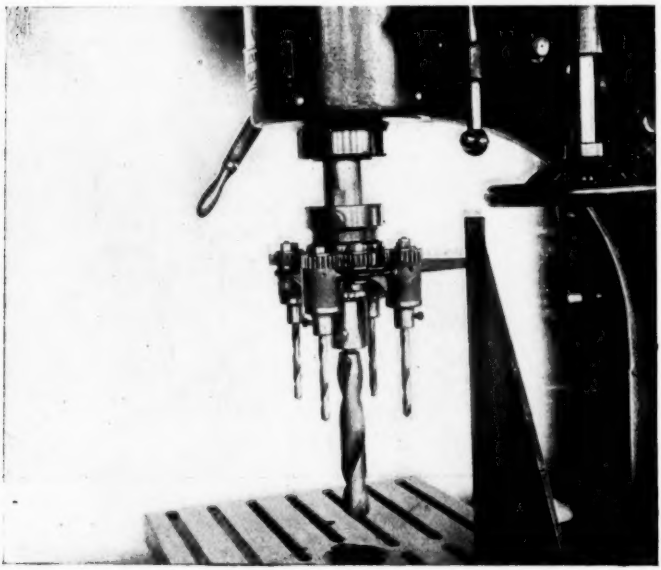
DE LA VERGNE CYLINDER-BORING MACHINE, TO BORE 20 FT. LONG X 120 INCHES DIAMETER. BUILT BY DE LA VERGNE REFRIGERATOR CO., PORT MORRIS, N. Y.



NEWTON DOUBLE ADJUSTABLE SPINDLE HORIZONTAL DRILLING MACHINE FOR CONNECTING ROD ENDS. DE LA VERGNE SHOPS. BY NEWTON, PHILA., PA.



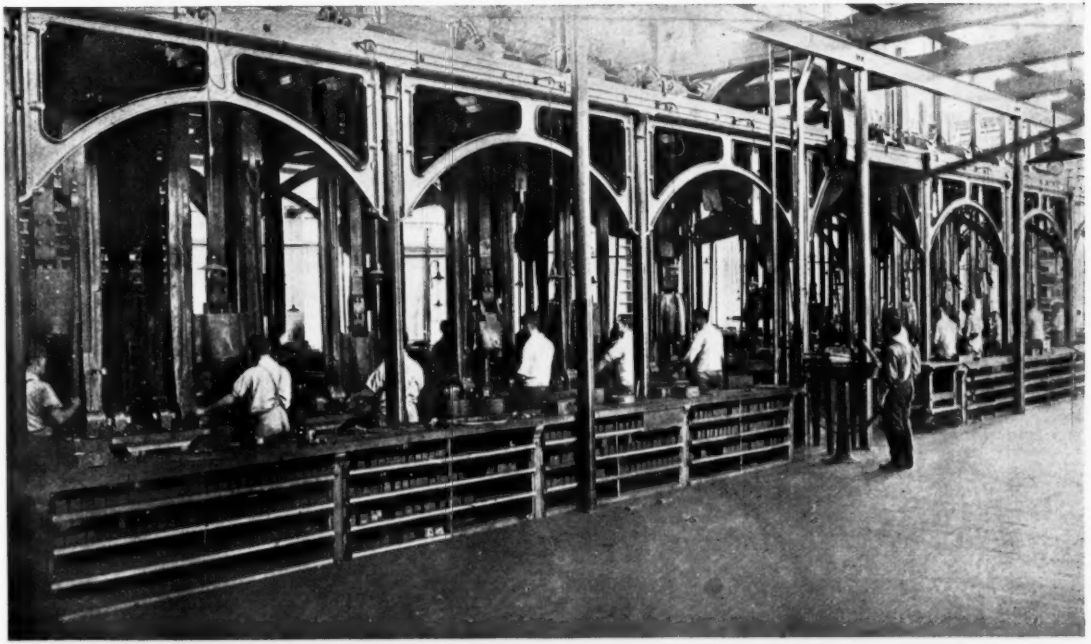
ELECTRIC-DRIVEN LOCOMOTIVE-CYLINDER REBORING MACHINE. DESIGNED AND BUILT BY C. M. & ST. P. RAILWAY, MILWAUKEE SHOPS.



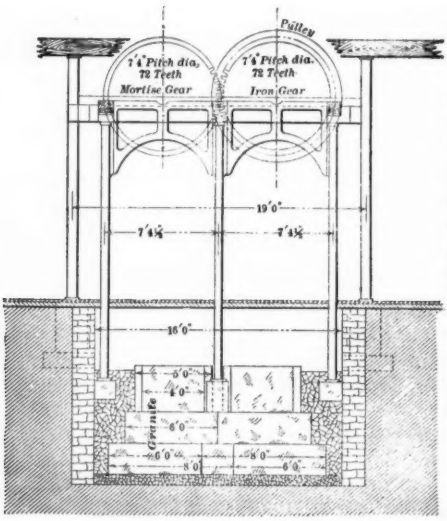
5-SPINDLE DRILL ATTACHMENT. CHICAGO, MILWAUKEE & ST. PAUL RY. SHOPS, MILWAUKEE, WISCONSIN.

yond ordinary machine-shop practice that few superintendents would demand a tool capable of such a performance.

The steam hammer was so late in making its appearance that the eager demand for its best services led to rapid development, and it very quickly reached such conditions of effectiveness and satisfactory detail as to leave little to be desired. With the drop hammer the case is somewhat different. There was, and still is, an entirely erroneous theory that rigid drop-hammer foundations are destructive to the machine, and that a certain degree of elasticity must be had to ensure successful drop-hammer practice. The magnificent bank of drop hammers on massive cut-stone foundations designed by Mr. Bogle and installed by the Gorham Company at its factory in Providence, R. I., fully demonstrates the propriety of placing the drop-hammer anvil on a perfectly rigid foundation. The Gorham experiment has been in most successful operation for a number of years, and conclusively proves that a rigid drop-hammer foundation not only vastly increases the effectiveness of the hammer blow, but reduces drop-hammer breakages to the lowest limit.

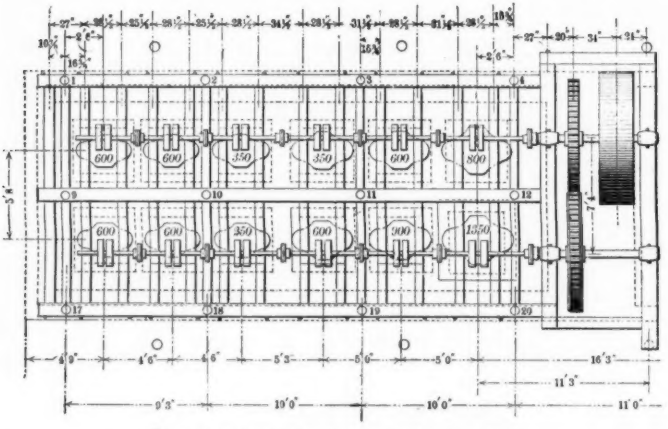


GORHAM MFG. CO. DROP-HAMMERS, UP TO 1300 LBS. DROP WEIGHT.



* GORHAM DROP-HAMMERS: END ELEVATION.

The electric travelling crane is an indispensable adjunct to the heavy-machine floor, is perfectly well known, and is mentioned here only to avoid a possible charge of inadvertence. For lighter work there are hand travelling cranes, some of which weigh as little as two tons each, and can very easily handle five-ton pieces. There are also valuable systems of overhead railways provided with hand chain hoists, which are well known and widely used. For the foundry floor practice varies; the heavy foundry may well have its moulding space wholly covered by an electric travelling crane. Electric jib cranes may be used on the foundry floor, each one covering a space



* GORHAM DROP-HAMMERS: PARTIAL PLAN.

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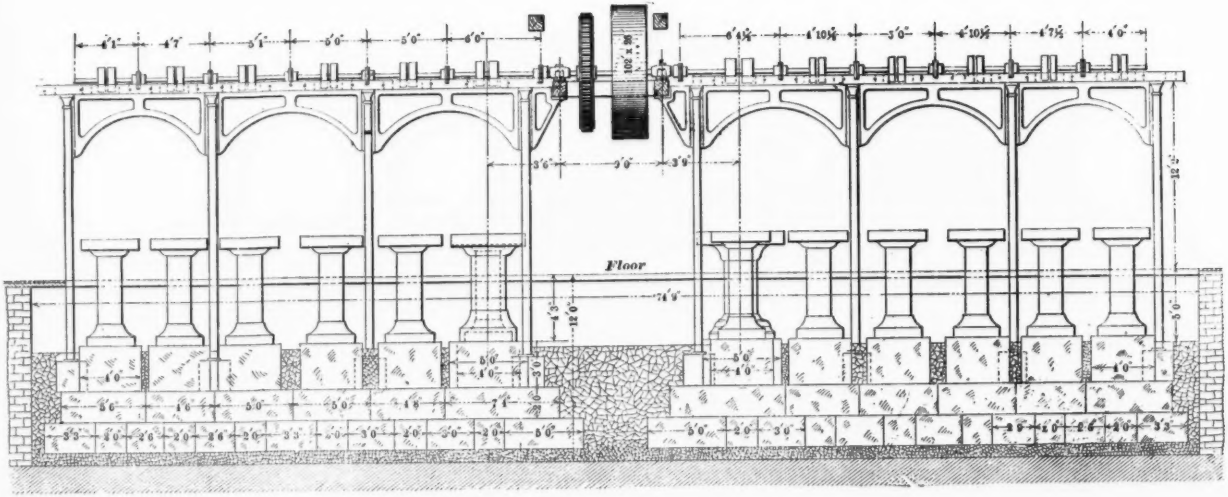
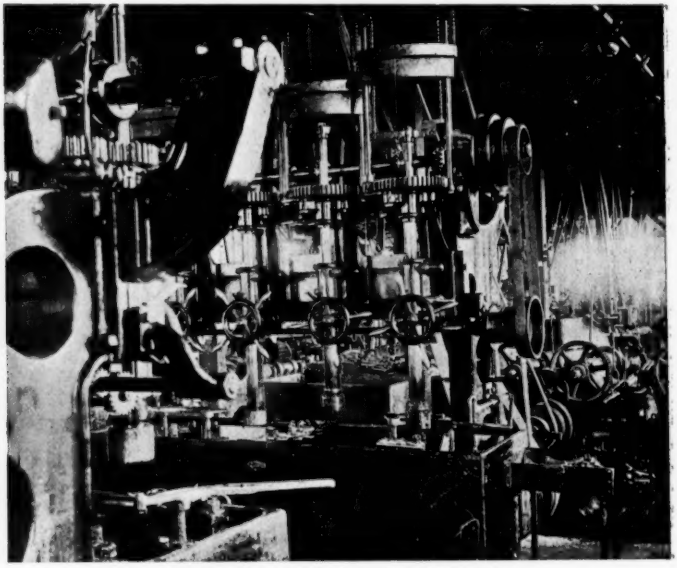


GORHAM MFG. CO'S HAMMER FOUNDATIONS. DESIGNED BY J. M. BOGLE, SUPT.

Reprinted by permission from the *American Machinist*.

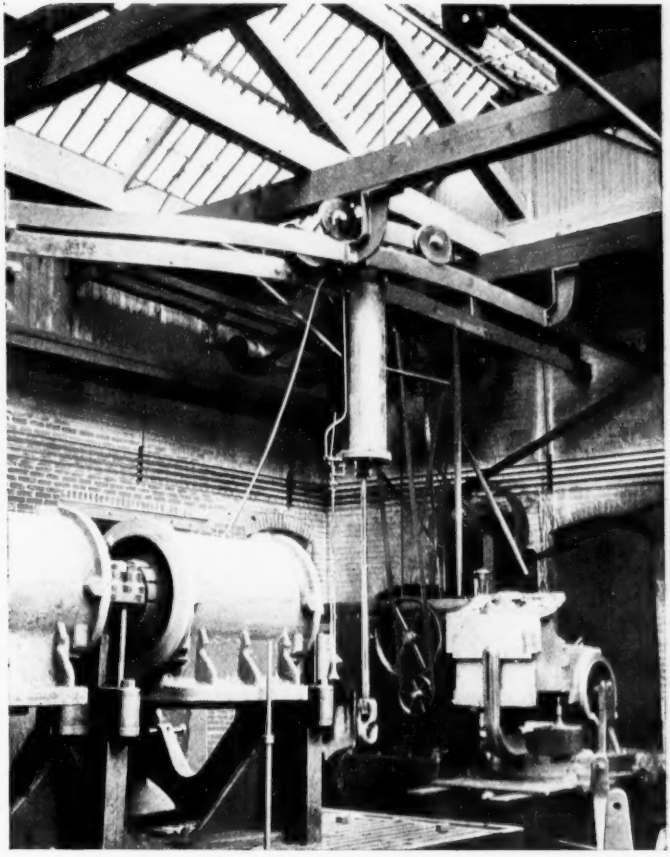


VAUCLAIN'S TAPER-BOLT TURNING MACHINES.

One man turns 1000 to 1200 taper locomotive bolts 8 inches long in 10 hours. Work is submerged in oil-tanks. Baldwin Locomotive Works, Philadelphia, Pa.

occupied by one gang of moulders, and in very many lines of foundry work the air hoist is indispensable, especially in connection with moulding machines for the heavier forms of machine-moulded work, as on the Deering ground-wheel floor, and the Milwaukee Harvester Company's Reaper Frame floor, where Mr. G. H. Schulte, superintendent, has reduced the per ton labor cost of the heavier parts of reapers and mowers from $6.60 to $2.40, by the use of moulding machines and air hoists, while the piece-work earnings of his moulders are now a little more per week than they were at the $6.60 cost rate, and their work is easier. Wherever the continued use of a piece of grey iron is tolerably certain, the special moulding machine should be employed in its production; the lowest foundry labor cost cannot be reached without the use of moulding machines and the air hoist.

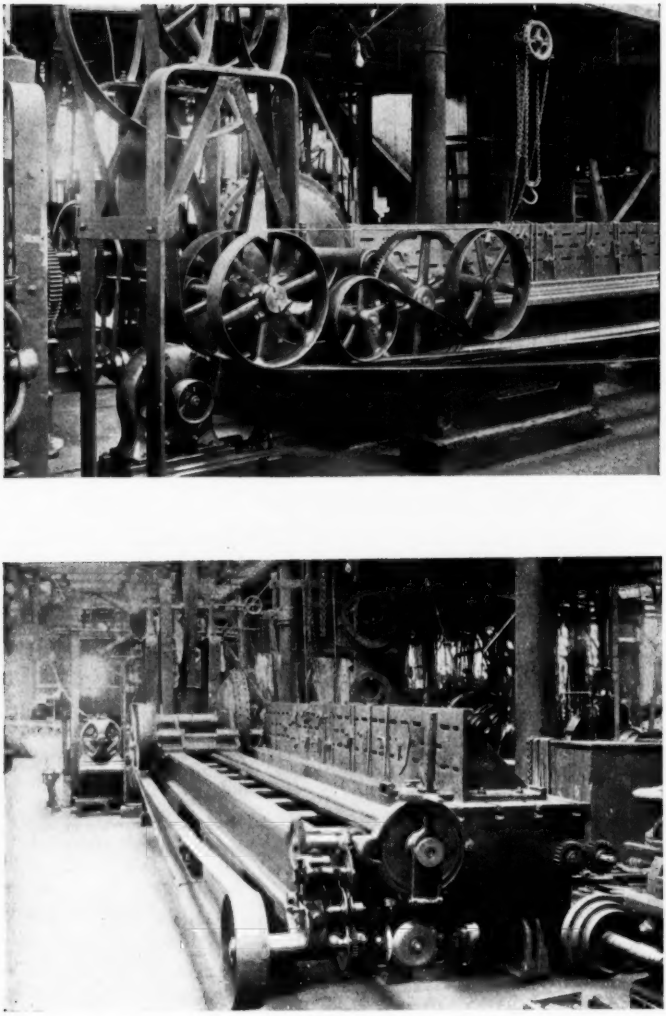
The air hoist may also render very valuable service on machine floors covered by heavy travelling cranes; the cost of each air hoist is very small, and it will often save time which would be lost while waiting for the big electric crane. It is peculiarly adapted to "rolling



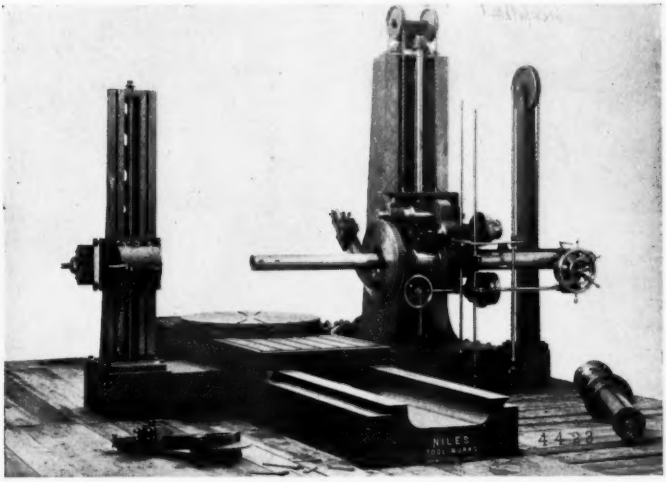
AIR HOIST, CYLINDER ROOM, RHODE ISLAND LOCOMOTIVE WORKS.

over" and to cope lifting, because of the softness and absence of jar in its action. It is also a great labor-saving aid in setting work on heavy planers, the air hoist in this case being a regular part of the equipment of each tool, always at hand and ready for use by the individual workman, who finds it far more efficient than a gang of helpers, who in many instances have to be collected at some loss of time.

The substitution of mechanical lifts for the moulder's muscle is the one marked feature of improved foundry practice. Jib cranes,



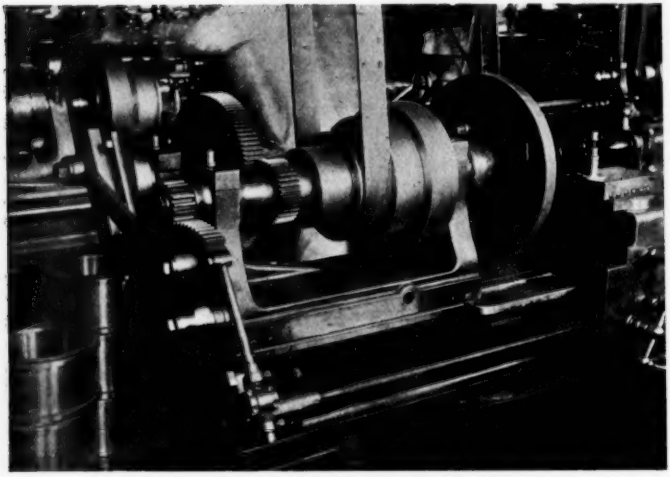
TWO VIEWS OF SELLERS LOCOMOTIVE DRIVING-BOX SURFACING-MACHINE. BALDWIN LOCOMOTIVE WORKS, PHILA., PA.



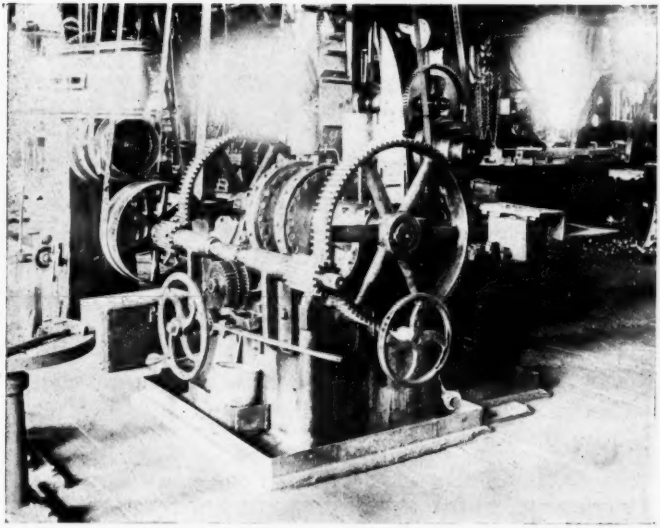
HEAVY TRAVERSING MACHINE : NILES TOOL WORKS, HAMILTON, OHIO.

travelling cranes electric in all cases where power driven, light overhead ladle carrying devices, and air hoists variously hung, are the noticeable modern innovations.

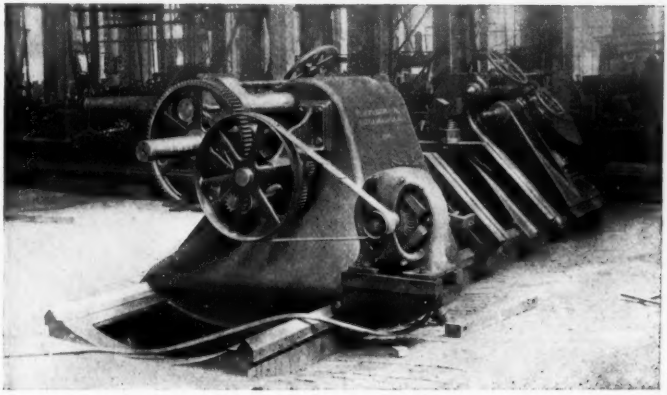
At the present time electric driving of machine tools is in a transition stage of development, which may end in complete systems of individual motor driving, or in mixed systems where separate motor units of not very large capacity drive short lines of shafting. There seems at present a strong probability in favor of a final verdict for the individual system, where each tool is driven by its own independent electric motor. There is every reason to hope that all overhead shafting, pulleys, and belting may disappear from the machine shops, as these hitherto indispensable elements of power transmission are dirty and expensive light-obscuring annoyances ; the sooner they go, the better for all concerned. It is possible that the next five years will suffice to nearly abolish the leather belt in American practice. The rope drive, so long and favorably known abroad, is probably cheaper, and in every way better, than belt driving from the engine to the dynamo. A very recent installment is that at the Edison Power house, Paterson, N. J., where the arc light dynamos are rope-driven from vertical Ball and Wood engines. Another example is to be seen in the 1896 addition to the Monarch cycle shops, Chicago, where the line shafting of the multifloored extension is rope-driven. Line shafting and leather belting possibly are still debatable points, with the probabilities, however,



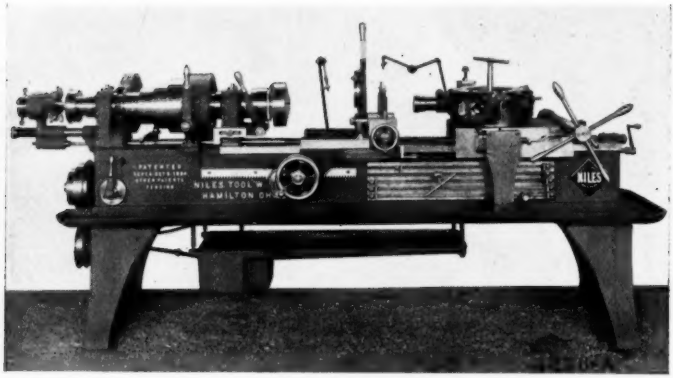
OSCILLATING LATHE FOR ROUND-END CONNECTING-ROD BRASSES.
DESIGNED AND BUILT BY DE LA VERGNE REFRIGERATOR SHOPS,
PORT MORRIS, N. Y. FRONT AND END VIEWS.



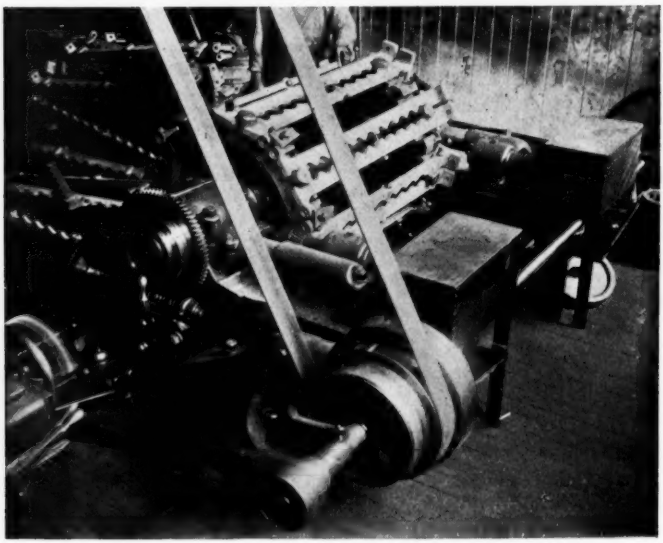
SPECIAL CONNECTING-ROD STRAP SURFACING-MACHINE. DESIGNED AND BUILT BY BALDWIN LOCOMOTIVE WORKS.



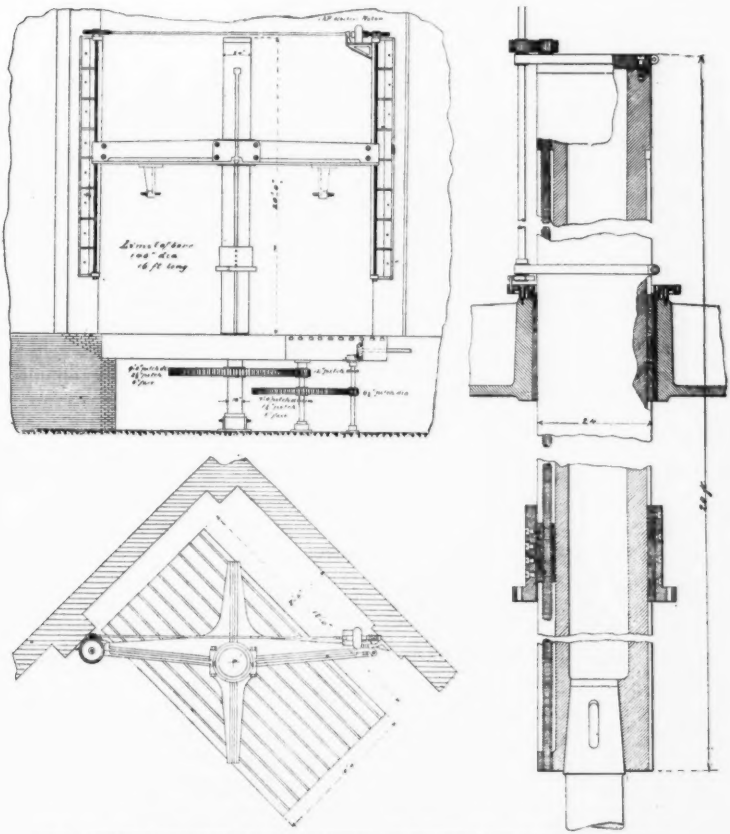
ELECTRIC-DRIVEN QUARTERING-MACHINE, BALDWIN LOCOMOTIVE WORKS. BY BEMENT & MILES, PHILA., PA.



NILES TOOL WORKS HEAVY TURRET MACHINE.



NEWTON SPECIAL DOUBLE-MILLING MACHINE, FOR FINISHING ENDS OF PIPE-STANDS TO LENGTH. DE LA VERGNE SHOPS. BUILT BY NEWTON, PHILA., PA.



DE LA VERGNE CYLINDER-BORING MACHINE, ELEVATION AND PLAN AND SECTION OF BORING BAR.

vastly in favor of a condemnatory final verdict against both, although no sufficient time test has yet been given individual motor driving to make its future use an absolute certainty.

Artificial lighting by candles, lamps, gas, and incandescent electric lights, all of which are easily within the personal experience of machinists still in service, is faulty. Arc lights, supplied with large concave reflectors underneath, so that all the rays are first reflected upward, will, in connection with white overhead work, light a machine floor so that the change from day to night will not be noticed by the

workmen. The De La Val shops are so lighted, the whole interior of the shops being painted with white asbestos paint. This method of lighting leaves absolutely nothing to be desired.

Ventilation should be, possibly, wholly by artificially-induced air currents. It is not desirable to pierce the side walls of workshops with windows. Undoubtedly the first cost of artificial ventilation is less than the cost of time lost by workmen in opening and shutting windows to gain an imperfect air circulation, which at best annoys some hands as much as it pleases others. A closed building even of very great extent can have all of its contained air changed as often as needed, and its temperature kept as desired, by the use of the blower. It is but rarely that a room perfectly ventilated and not exposed to the direct rays of the sun needs artificial cooling to make it tolerable to workmen; it seems likely, however, that entire control of workshop temperature, in cooling as well as heating, would be found economical. In the case of, say, five hundred workmen, saving a very small loss of efficiency in each due to high temperature of the shop would make artificial cooling an economical practice. The drawing-room should certainly be artificially cooled, as very few men are capable of continued mental effort in a temperature above 80 degrees.

There can be no question as to the desirability of a certain degree of cleanliness, education, and self-respect on the part of the workmen. The dirty slouch covered with machine grease is not the ideal machinist. But the moment a man has been cultivated to the point of personal neatness, he begins to take offence at enforced intimacies with unclean things. It is true that habit will lead to toleration of repugnant conditions. A modern office-building is precisely like a shop in one of its conditions; it must acceptably house a vast number of workers during working hours. Certainly no office-building which provided only the ordinary machine-shop facilities for privacy could find tenants. It is true that there is a current belief that machinists are of coarser clay than clerks and office-workers, yet it seems not improbable that a regard for natural decencies might be inculcated even in the rude nature of the mechanic by a few generations of service in shops where decency was made possible. There is also a belief that machinists, boiler-makers, moulders, and blacksmiths must be coarse and brutal to be effective workers, and it is probably true that education and refinement will lead a machinist to look with disfavor on such a job as putting a repair crank on a screw shaft in the hold of a tramp steamship in company with tallow candles and dead rats washing about in the bilge water, which is certainly not an agreeable all-night occupation. But the experience of all foremen will probably sustain the assertion that, in emergencies, his neat and intelligent men serve his

purposes best, and closets should be such as not to offend such workmen, either by enforced association or lack of ventilation.

Refectories, or eating-rooms, are in some places accepted by American workmen. Libraries, reading-rooms, and free shop night-schools are of little use, because few men care for books, and those who do commonly own them and prefer to use them in solitude. Also, the workman who wishes to study at night commonly prefers to pay for attention he seldom receives at a free school. Men who seek an education after they have reached the journeyman's estate are rare, and are disposed to shun the crowd and work alone. The Straight Line Engine Shops at Syracuse went to some trouble and expense with a reading-room, which is now used as an odds-and-ends store-room; the hands would not enter it. The Baldwin Locomotive Works has, I believe, something of the sort. Night drawing-schools connected with the shop, and giving instruction in mechanical drawing and mathematics at a nominal tuition cost, are often largely attended; and such a department should be an adjunct of the drawing-room in every large establishment, as the education therein imparted is of distinct value to both the workman and the management.

The necessity of the tool-room and small-tool check system are too well known to need more than mention. Some large shops still permit workmen to grind tools to suit themselves. The cutting edges of tools, excepting those of tool makers and piece workers, should be under shop control; this can be the case only where tools are ground in the tool-room. In a large establishment each department must have its own tool-room and grindery, and tool system generally, as the requirements of departments differ, and distance forbids the use of one tool-room for all.

Time-keeping, either by the check or the individual clock-key system, may be said to be established. The check alone can be made to answer every purpose very cheaply, and has as few objectionable features of use, perhaps, as any known method of recording the arrival and departure of hands. With the form of shop proposed in the last paper, the check-boards can be lifted to the gallery floor for the replacing of the checks, so that the check-boy need not go down into the shop departments.

A full telephone equipment is, of course, indispensable to any large establishment. In the Deering Reaper Shops, Chicago, the central telephone office is located at one side of the entrance room, and the girl in attendance is usually able to give information as to the whereabouts of most of the officials who meet strangers.

An application of the common hotel annunciator might be made in connection with the telephone system. There are seldom more

than, say, ten officials whose duties may call them to many parts of the works. Place a row of, say, twenty push buttons, two for each of these wandering officials, at the telephone stand or entrance of each department; these buttons wired to annunciators in the personal office-rooms of these officials, and to any other desired point; probably the telephone central office and office of the general manager, in addition to each official's own office, would be enough. Each annunciator would have under each official's name numbers indicating every shop department, and an "In" and "Out" legend. Supposing Mr. Smith to enter his own office, he pushes the button, and announces his presence in the works to the general superintendent, and to the central operator; when he leaves his room, he pushes a button which covers his own office-number on all the annunciators; upon entering another department, he pushes his individual "in" button, and is duly announced as being at that location; when he leaves, he pushes his individual "out" button, and thus records his departure on the annunciators. By this simple and inexpensive means many hours of valuable time can be saved every day in any large establishment, as the exact location of every prominent man in the place whose duties cause him often to leave his own apartment can be constantly known by the central operator and the manager.

The importance of this proposed annunciator installment is really very great. It would earn its cost many times over every year, as it would supply a now missing link in that instant communication of individuals which is indispensable to the greatest production with the least cost.

The question of special machine-tool making affords scope for the exercise of mechanical talent and business prevision of the very highest order. A special machine tool is absolutely worthless, except in the production of the one particular piece for which it was made. It is always expensive, and it is always to some extent a hazardous venture.

The special machine tool may be of any size and weight,—from a few pounds to many tons. It may have any number of tool-carrying spindles,—from one to hundreds. It may simply drill, or it may drill, turn, bore, plane, ream, mill, tap, and thread. It may be and do anything; it may take any form; it may combine many operations, all executed without changing the location of the piece on which these operations are performed, or it may be the subject of the most minute subdivision, each machine being reduced to its lowest operative terms, and the work being transferred from one machine to another, either automatically or in bulk.

Generally speaking, where small articles are manufactured in vast

numbers, like wood screws or cartridge shells, the better practice is to divide and subdivide the duties of each special machine to the lowest limit; where the articles made are fewer in number, and the relative location of cuts is a matter of supreme importance, it is better to locate the work but once, and perform the operations by means of separate tool-carrying agents. A sewing-machine bed or an engine cylinder is best finished at one setting from geometric or living-axis-guided cutting-tools, instead of trusting the uncertainties of resetting to cuts already made.

Special tools should be introduced into any manufacture the instant that sale for the product is assured, because they reduce cost, sometimes to an incredible extent, and improve quality. A manufacture which is in danger of death from close competition may rise to instant control of the market by venturing sufficient capital to reap the full benefits of special-tool use. A machine frame which cost $10.60 to finish at piecework prices, with ordinary shop aids in the way of jigs and gages, was finished for 38 cents by the use of a special tool, and an intelligent introduction of special machinery in the entire factory put a balance of $35,000 on the right side of the ledger at the end of two years from the inception of the special-tool building, as against an actual loss under the previous system, which was thought fairly good. The well-informed superintendent has this vision of special tool-economy and supremacy constantly before his eyes. He has the strongest possible reasons for the building of special tools, and he also has the strongest possible reasons for continuing the old order of things. He may cause special tools to put the establishment he controls on the top wave of prosperity, or he may put the safe, slow-going, small-profit-paying concern into bankruptcy. Yet there can be little doubt that the error of the wise superintendent will always be on the side of special tools and low labor cost. Special tools for producing machine details are now a regular part of shop equipment. Screw machines, turret chucking machines, special planers, flat turret lathes, and engine lathes provided with specializing attachments are bought in the open market, and are of established good repute. Shall the manager content himself with these minor aids to cheap production, or shall he boldly produce expensive special tools, which will reduce his labor cost on large pieces to a mere fraction of the best his best men can dô with ordinary lathes and planers?

THE ARCHITECTURE OF HOME-MAKING.

By Charles E. Benton.

THE art and instinct of home-building is shared with man by many other animals, but this of itself can hardly be dignified by the name architecture. It is only when an effort is made to add to, or embody in, the structure some expression of the beautiful that the art becomes allied to the fine arts, and in time takes its place in their front rank.

But, however far progress may go on this line, it is evident that it must never lose sight of its primary concept; that it rests upon utility as its basic principle is as certain as that "the line of beauty is the result of perfect economy."

But there are utilities and utilities. There is the utility of the roof that shall deliver the rain-fall to its proper place, and of walls that shall debar the entrance of the frost-king; but there are higher utilities than these. The family life is to be protected, influenced, and developed, and in this the work of the architect is that of one who constructs environments, favorable or otherwise, depending upon his mastery of the deep significance of his art.

It has been well said, by a prominent writer, in reference to architecture, that the interior is its life and the exterior is but the expression of that life, and that we must build from the interior outward. This contains a hint of the truth; but, as it refers to only the building itself, it is evident that the full light had not risen upon the author. To build rightly from the interior outward requires that we shall begin at the family life and make the interior of the house the expression of that life, and the exterior the outward form of that expression. With this initial understanding of the subject is there occasion for wonder that the home-making instinct is suffering from atrophy in some instances, and in others is compelled into so many ready-made misfits that its present condition seems scarcely less a deformity than the famed foot of the Chinese lady? A century ago the house of an American family was, like the ancient baronial castle, a growth rather than a creation. The young couple began life in an establishment proportioned to their means, and, as the means grew and the family increased, the house changed and grew until, in its way, it became an expression of the family life; nay more, it often embodied in its additions and peculiarities of architecture the whole family history, as it were, in hieroglyphics; not the creation of a professional hour, but the embodiment of a lifetime of thoughts and necessities.

It is noticeable that these household temples of a former generation, only a few of which remain in this country, retain a rare architectural charm all their own, but of so elusive a character that the modern architect seeks in vain, with dormers and reentrant angles, odd floor levels and broken roofs, to make it his own. As well try to nail the sunbeam to the floor or entrap the fairies whom the good dames saw of moonlight nights dancing under the old oak trees on the lawn. The abject failure of such efforts was well expressed by a gifted Swedish lady, who visited this country some years ago. While sailing up the Hudson, her companion pointed out a battlemented structure of stone, exclaiming:

"Do you see? A castle!"

"Ah!" she replied, "but it is a *very young* castle."

All such attempts fall short of complete success,—success in its best sense,—because of the very patent fact that present life is not fitted to appear in past forms. I am not writing for that very limited class of prominent citizens aptly termed the "vulgar rich," who desire nothing so much in a residence as ostentatious display. They have their reward. But for those who desire harmony of details it is worth remembering that battlemented walls, with their alternate solids and open spaces, were made for archers' positions of offence and defence, and that, when incorporated into the architecture of a modern, peaceful home, they become entirely expressionless, or, at the most, can be classed only as rudimentary survivals. If it is really desired to give some expression of combativeness to a place which should be the seat of love and peace, it would be much more appropriate to put an electric disappearing cannon or a Maxim machine gun upon the lawn. We are wont to forget, in our admiration of past forms, that the men who planned and built those structures were, in their own day, men of the latest thought,—up-to-date men who most successfully applied their means to the then present needs. Let us, then, sincerely admire the beautiful forms in which a former life found fitting expression, but avoid the mistake of assuming that they are models for present needs.

If the soul doth build its house, as the philosopher avers, in an equally true sense does the family, when opportunity may be had, build its house also. Yet, while the family builds its home, the converse is equally true,—that the home ofttimes shapes and moulds the character of the family; so, if the teachers of other arts and literatures have their burden of responsibility, in still greater degree must the priesthood of our own cult know that they also are their brothers' keepers.

Character is an edifice, artificial to some extent, built up through

the ages from a foundation of inheritance which reaches down into the sources of our civilization.

Each cube of virtue is grasped first by conscious effort and held to its place until, by the hardening cement of habit, it is fixed, itself becoming foundation for further attainments, and effort being released to go forward to further accomplishment.

In the plastic period of childhood the most strenuous builder of character is the family life. How important, then, it is that the architecture of the home should be such that this influence may have its freest and most beneficent development! I have in my mind a certain house of imposing exterior, but so curiously arranged within—or, rather, misarranged—that in not a single room is there a place where the entire family can unite socially; not a broad table is there within its walls where the latest papers and magazines with the newest books can be so laid as to be conveniently accessible. It is true that much of this effect is due, in this instance, to a system of housekeeping which has for its guidance a false objective,—a worship of house rather than household. Such houses must nullify, to some extent, the best efforts towards character-building by means of family influence, for the reason that they are not unifying, but disintegrating, rather, in their influence, dissipating the affections and energies instead of concentrating them. If these things must continue, 'twere better far that our furnaces and steam-heaters were cast into the sea, and we were driven back to the ancient fireplace, which, with all its discomforts, compelled the whole family group to its radiant circle. Under its concentrating influence the family life was intensified, and the strenuous virtues acquired deeper strength and vitality.

We may not doubt that the fireplace of the great family-room of our forefathers is entitled to a prominent place, with the Bible and the public schools, in that group of dominant influences that did so much to form an American type of character. I recollect, even in my own day, a great room spanned with sagging beams and containing unestimated cubic feet of breathing space, and I can scarce credit my memory as it enumerates its vast contents. The magic influence of that room was such that wholesome character was developed and maintained, and five generations have gone thence into the world in succession, making its potent influence for the right felt in many communities.

No one rightly values his profession who does not desire to bring it into line with eternal rightness in all its bearings; and, in order to do this in architecture, we must arrive at a right estimate of comparative values. Much is said about the responsibility of the architect as an educator of the public taste, but it seems trivial indeed compared

with the far greater responsibility resting upon his shoulders as one who has the making of the mould, so to speak, in which is formed the future character of the community.

"The friction of daily contact with the world grinds character to its keenest edge, but upon home influences it must depend for its temper, without which its keenness would be, at best, but a crumbling edge."

It is not within the scope of this article to treat, in fulness of detail, of the mechanical methods by which just results may be obtained, but, rather, to point out that the profession has a deeper significance than perhaps many of us have yet reflected; that it is entitled to an equal standing with those other professions that are considered to hold the key to the community's welfare. The means to be employed are as varied as are our resources. The grouping of rooms by which privacy and quiet may be secured where it should exist is to be duly considered, as well as that greater desideratum, the opportunity and encouragement for joyous sunlit family intercourse, the great healer of the world's sorest wounds.

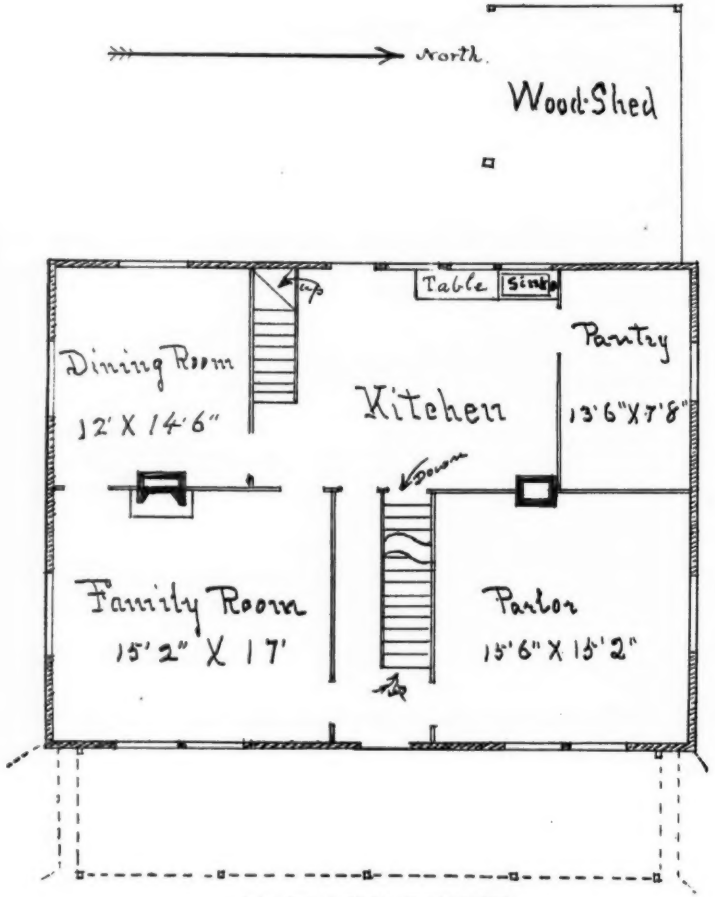
As has already been hinted, in the application of architectural principles to home-building the first prerequisite is to know the life of the family which is to use the home, and equally the means at disposal for the purpose. These are the two determining factors, and, thus considered, the subject can not be thought to properly include millionaires, as their means are practically unlimited, or the very poor, since they have no choice in the matter, but must find shelter from the elements as best they may. But for the great mass of useful citizens between these two extremes,—the earning, renting, owning, "easy," and wealthy,—both these factors must be considered.

It may be surprising to learn that professional architects have given comparatively little attention to the homes of a very large class of citizens. I refer to farmers,—more than half the population of the United States. In conformity with their method of life nothing more befits the farm-home than directness and simplicity combined with generous space, and the best success is obtained by not clinging too closely to the customs of metropolitan life. The farm offers wider variation in regard to means and family customs than is to be found elsewhere, but the same rule must prevail,—that the house should conform to the best life of the family whose home it is. To illustrate this I have selected the farm-house shown in the plan on page 700.

In this instance the size of the family and the limited means at its disposal made it imperatively necessary that the utmost available space should be enclosed at the minimum of cost.

An easy error to have made in this plan, and one which would

probably have been made if the matter had been left to the country carpenter, would have been to include a re-entering angle at the south-west corner, the effect of which would have been to eliminate the dining-room and one chamber without in the least lessening the expense of the building. It may be objected that the work of the household is here given too central a position, but it must be considered that, as the family keeps no servants, work—and for the female members

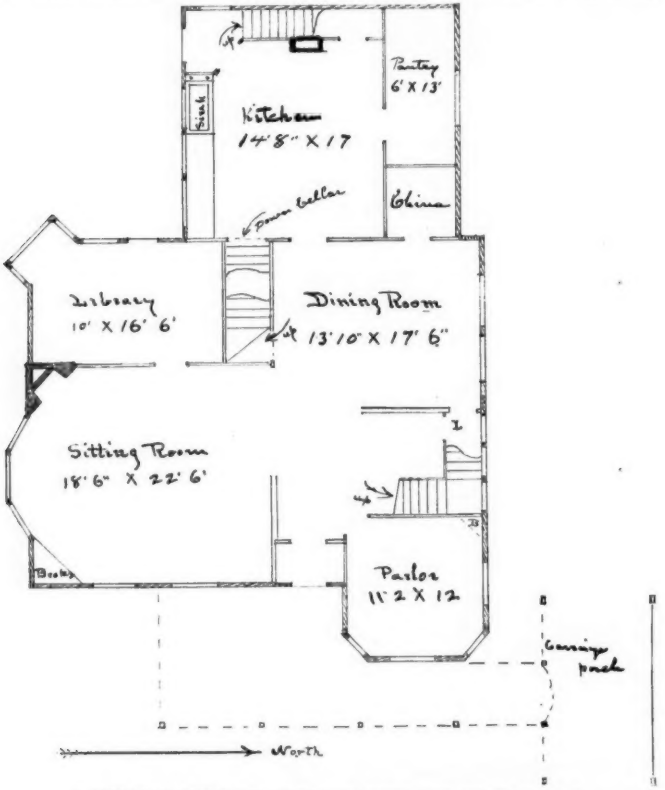


PLAN FOR A SMALL FARM-HOUSE.

household work—is the central fact in the family life; and this acceptance of the fact bestows a certain dignity which could be attained in no other way. In the sphere of utilities the house seems especially adapted to the needs. The location of the wash-room and laundry in the basement removes the coarser work from the inhabited rooms, while the central position of the kitchen enables the labor to be performed with the fewest possible steps. It will be noticed that every room in the house receives its full quota of sunshine at some time in the day. As the house stands well back from a country road, there is no occasion to conceal any part of the immediate grounds, as is desirable in town or suburban homes; but whether the family group be gathered in the dining-room, which looks out to the distant western and southern horizon, or on the broad piazza at the close of a summer's day, or, in the chill of autumn, about the fire in the family-room, with its beautiful outlook and its daily flood of sunshine,—whatever the time or season, everything combines to strengthen the family ties, and the passer-by will recognize at a glance in the plain, even severe, simplicity of the house, as it reposes in the well-kept lawn judiciously set with trees and flowers, the home of a family living in consistent harmony with environment.

Perhaps I can better illustrate the central thought which I have endeavored to explain by a home which combines, to some extent, the elements of metropolitan and country life. This is shown in the following plan of the home of a gentleman who, while attending to his business in the city, makes his home at the outskirts of a country village, an hour's ride from town, and who willingly submits to the inconvenience of living at a distance from his business in order to secure the advantages of a real home for his family. The establishment has spacious grounds, and includes a farm also. The arrangement of the grounds may be briefly described as follows, showing their relation to the house itself. The carriage-house with its adjoinings are northwest of the house, and by trees and shrubbery are suitably obscured, while from the street on the east and running northward a beautiful view may be had of the house and so much of the grounds as are intended for the public eye. There is a beautiful lawn to the southward, which includes not only ornamental trees, shrubs, and flowers, but a tennis-court and croquet-grounds as well; and all so well secluded by evergreens and hedges that the visitor gets no glimpse of its charms until he is well within the gate. Yet the contour of the ground is such that, with care in the arrangement of trees and clipping of hedges, the beautiful landscape is not obscured in the view from the house. This home lawn bears much the same relation to the rest of the grounds that the great family-room does to the other rooms.

Returning now to the interior, I will remark in passing that the American parlor has become so firmly established in our homes that its assumed necessity must be conceded to have some foundation in reality. It is not alone in the houses of the rich and well-to-do that this sentiment prevails, but on this point the farm dame in her secluded home and the mechanic's wife agree. At some future day



A SUBURBAN DWELLING, BLENDING TOWN AND COUNTRY LIFE.

a syndicated social clearing-house, with its various branches, may succeed in effecting an exchange of formal visiting cards and save the tiresome waste of present formalities, but, until such time, formal society calls must be made in person and received in a parlor. Moreover, we are not yet so old as to have forgotten how useful a parlor was when one or more members of the family desired to entertain

company without the presence of the whole family. Yes, the parlor must be conceded as a necessary part of a complete home, but it must not be permitted to dominate; instead, it must be placed in a subservient and appropriate relationship,— must, in short, be a servant, and not a master, of the family life.

In this house the hall is seen to fill its sphere admirably. It contains no great and ornamental fireplace, no easy lounging-chairs and table of china; in fact, there is an entire absence of those conveniences, so much in vogue at the present time, which tend to convert the hall into a family sitting-room, and thus defeat its best uses. Instead, it is confined to its true utility as an apartment of entrance. But it is spacious, and made very pleasing by the subdued light from the windows on the stairway, which light the upper hall as well; and on social occasions a very pretty effect is gained by throwing the three principal rooms together. There is a lavatory under the stair-landing, opening into dining-room and hall. While the dining-room is commodious and gives a pretty glimpse of the street and village towards the north-east, the great family-room is the recognized center of attraction. The floor is covered with matting not too good for daily use and in no danger of fading by the floods of sunshine admitted through the great south window. In sultry weather the vine-screened piazza has its attractions, but the chill of evening is dissipated by a fire in the open fire-place, and in winter, though the house is heated by a furnace, the open fire, consuming wood cut on the farm, adds a charm which is no less potent now then it was when Ik Marvel sung its praises. Here is the great center-table loaded with the newest books and magazines; the piano and the quiet games of childhood; the work and reading of the older members; in short, here is the life—I use the word in its completest sense—the life of the family; and dull and irresponsive indeed must be the nature of one reared in these influences who could find stronger attractions in the saloons. Adjoining this room is its necessary adjunct, the full usefulness of which is not indicated by its name,—"library." Besides its table and shelves of books, it contains the master's desk, and is, in one of its uses, his home office, its outside door making it convenient for council with the farm forces. It also furnishes a retreat on special occasions for other members of the family. Of the upper floors it is not necessary to speak in detail. The bath- and toilet-rooms are on the second floor, and the rooms of the female servants are on the third floor, while the laundry is in the basement.

In studying this home, it will perhaps assist us to a fuller consideration of the subject if we reflect upon the possibilities of failure presented by these conditions. The architect of city structures who could

not free his mind from the habit of thought engendered by the necessity for narrow frontage and close proximity of the street might very easily have erred by giving a narrower frontage and greater depth, and, following the same habit of thought, would have divided the great family-room, and called the front room thus made a "reception room," a sort of lesser companion piece to the parlor, and furnishing one more enclosure from the sunshine.

Nothing would so completely destroy the divine harmonies of home life as a change of that kind, for the apartments of ceremony would thenceforth tyrannize over and dominate the domestic apartments. There being no room for the organic family life to attain its freest development, it would, almost of necessity, become fragmentary. The mother would find a room up stairs for her reading and work, while the boys and girls, feeling, without understanding, the undefined want in their home life, would go forth into the world, as so many have done, without that restraining influence in the character which is seldom acquired outside of home.

It will not be necessary for me to adduce further examples to illustrate the one thought that I have sought to explain in connection with this subject. Whatever in home architecture tends to separate the family into groups must, to that extent, annul family influence, because such influence depends for its best success upon the solidity of the organic home life.

I have not thought it necessary to treat specifically of the exterior, yet the same principles will apply to some extent here also. We have seen that the interior should embody a symmetry in just keeping with the family life; if this thought is elaborated consistently, the exterior will, almost without effort, give expression to that consistency in an effect both pleasing and restful, and the structure will become a finished section of its surroundings, or an attractive point within it.

The architect who justly respects his profession will approach his work in the reverent spirit of the old masters who held their task so sacred that each part was wrought to its fullest perfection, regardless of whether it was to be seen in the particular niche it was destined to occupy. For who shall say when will cease the influence of those who construct the mould and environments which are to give form and direction to character, sentient or unborn?

JAPAN'S INVASION OF THE COMMERCIAL WORLD.

By Allen Ripley Foote.

JAPAN may become the leading industrial and commercial factor in Asiatic trade. It may be supreme in its own empire. But there are ethnical reasons why it can never be sovereign beyond the zone of its oriental influence.

In basing its campaign for commercial conquests upon its readiness to adopt foreign inventions without giving compensation, and its ability to erect manufacturing establishments in which to employ its cheap labor, Japan exhibits its inferiority. So long as the creature is inferior to its creator, so long will an imitator be inferior to an inventor. By refusing to recognize the right of property in an idea, through declining to protect the rights of inventors to their property, Japan deprives itself of the advantages it might derive from inducing the inventors of the world to assist its development by establishing their undertakings in its empire, and condemns its own workmen to remain imitators by withholding from them the stimulus of reward for acquiring inventive talent. This failure will prevent it from bringing and maintaining its industries abreast with the best developments of the age.

Two incidents may be cited to illustrate these points. It is reported that a representative of the Japanese government came to Chicago to buy several electric-lighting plants for the home palaces. He bought one, and was not heard from again. A Chicago gentleman visited the palaces later, and discovered half a dozen copies of the original plant in use, made by Japanese workmen, even the name-plate having been reproduced. It is also said that a Japanese agent bought a piece of machinery in Chicago, and then stated that he could have it reproduced at home for just one-half its cost in America. These are illustrations of the inherent weakness of the Japanese character. The absence of a delicate sense of honor is shown by the copying of an American manufacturer's name-plate and placing it upon a Japanese imitation of his work. Inability to comprehend the forces that are the true sources of power and greatness is shown by the cunning assumption that want of power to originate a machine can be overcome by ability to copy it. How can imitators hope to keep themselves abreast with a nation of inventors and originators? By the time their inventions are sufficiently developed to be felt in the world's markets, the designs will be out of date. The intelligent will not have them.

Japanese cheap labor is a chimera. Enthusiasts have talked about the possibility of Japan flooding the United States with cheap buttons, bicycles, matches, sashes, doors, blinds, and all kinds of wooden ware, with duty paid, at from thirty to fifty per cent. less than the wholesale prices charged for the same goods by American manufacturers. In considering such statements, it is well to remember that the basis of comparison is false, because such goods as the Japanese would send to America in these lines are not made in the United States. Japanese imitations are inferior goods. Their appearance and cheapness may enable them to find a market in Asia (where the people are not good judges of quality) until orientals get better acquainted with American products, but there is no probability of their obtaining a permanent foothold in Europe or America.

Low rates of wages do not determine low cost of production. Wages are higher in the United States than elsewhere, but American manufacturers can undersell Englishmen in their home market, in many lines, and dispute trade with the poorest-paid labor in the markets of continental Europe. The secret lies in being able, by the aid of ingenious devices and labor-performing machinery, to increase the output enormously per dollar of labor cost. The course of events will show that labor cost will be decreased in America in the future, as it has been in the past, by the use of well-devised labor-performing machines under the management of highly-paid workmen possessing great skill and intelligence, and that it will be increased in Japan as the workmen become more intelligent and conceive higher ideas of living. The Japanese of the next century will have more wants than the Japanese of to-day, and will demand many times the present rates of wages. This movement is already being felt. In the last seven years, according to Japanese official reports, the wages of females employed in cotton spinning have increased thirty-seven per cent.

Under date of January 14, 1896, the late Col. John A. Cockerill wrote to the New York *Herald:*

> For the last four months there has been a steady demand upon the part of salaried men for an increase of pay which would enable them to live comfortably. The government has led off recently by doubling the salaries of all its foreign employees. This has been followed by a number of big corporations. They have yielded to the demands of their people after the usual struggle, and this is the beginning. Wages are everywhere being pushed up, and in all branches where skill is required. Not a business concern in Japan will escape the effect of this curtailment of profit incidental to a fifty per cent. increase in salaries and wages.

This will wipe out the margin by which the Japanese have announced that they will undersell Americans in their home markets. Japanese workmen, in their attempt to compete with American machinery, are destined to meet the same fate now being experienced by

Chinese laundrymen in the towns of western States, where the American steam laundry has driven them entirely out of the business.

An American watch-manufacturing plant is in operation at Osaka under Japanese auspices, but, with the best of machinery, it has not been demonstrated that a good low-priced watch can be made by Japanese labor.

The Japanese bicycle is not neat, comfortable, or durable. It could not be sold in the United States at any price. While this is true of Japan-made bicycles, American-made bicycles find purchasers, among the class of Japanese who are really intelligent, at prices ranging from $100 to $125 in gold.

Japanese matches are inferior. They are mostly hand-made, and cannot compete with the product of American factories where whole pine logs are fed into voracious machines which turn out matches ready for the market.

This failure to judge of quality is causing Japanese manufacturers to dispense with foreign mill managers in the cotton industries and fill their places with natives. The same thing is being done in railroad construction and management. They are assuming capabilities they do not possess.

The following statement was published in "The Japan Weekly Mail," copied from an English journal:

> A locomotive was bought in England for £1,550, freight and duty paid (£242) bringing the total cost of the British-made machine to £1,792. That is one story: here is another. A similar locomotive was built in Japan, from English designs and in great part from English material, by native foremen and workmen, its total cost being £1,349, against £1,792 for the engine built in England.
>
> Now, this may be the beginning of considerable change. If, as in the case of the locomotive engine built in Japan, the greater part of the material was imported from England, and then handled by native labor at so great an economy of money, it is possible that this movement may be carried very much further, and it is one to which English workmen should give their attention.

It is said that skilled labor in Japan is paid from 15 to 25 cents per day. In England it is paid not less than $1.50 per day, five hundred per cent. more than in Japan, but the saving here shown is only thirty-three per cent. on the reported cost of the Japan-made engine. If it is estimated that one-half of that cost was paid for labor, the material, in a more or less finished condition, having been bought in England, and if all of the apparent saving be credited to difference in cost of labor, the gain made by employing native labor appears to be sixty-six per cent. on the labor cost. Why was it not great enough to show a saving of five hundred per cent., the reported difference between the rate of wages in Japan and England? It must be inferred that the poorly-paid workingmen of Japan are less efficient than better-paid workmen of England, and for this reason more days' work

had to be paid for in Japan than would have been paid for in England. This increase in the number of days' work paid for cuts down the apparent gain from the five hundred per cent. that it should have been on the evidence of the difference in the rate of wages to sixty-six per cent. on the evidence of the pay-roll. Some important lessons may be learned from this fact. The increase in the Japanese rate of wages which is now in process, or an increase in the English output per dollar paid for wages by the use of labor-performing machinery, will quickly overcome all difference in cost, leaving the Japanese no advantage whatever.

It is perfectly safe to make another point. It is not within the range of probability that the Japan-made engine will be as economical in use and service-life as the English-made machine. The difference in economy in use may easily wipe out all of the difference in economy of first cost, so that, as a final result, the Japanese may have saved nothing. A prediction may be ventured. If the Japanese will advertise for bids from the United States for engines guaranteed to perform the same service that is obtained from the Japan-made imitation of the English engine, with as high a rate of economy in service and as long a service life warranted, they will get engines at a price which, combined with economy in service, will leave no profit on Japan-made engines at the cost reported for this one. These conditions will hold good for all classes of machinery.

This whole problem was fully comprehended in the reply made by Mr. Charles Cramp, when asked what would be the difference in cost between two steamers exactly alike, one built in an English ship-yard and one in an American? His reply, in effect, was: "There can be no such basis of comparison, as Americans can not build a steamer just like one built in England. If they attempted it, they would, from force of habit, build a better one."

With Japan the reverse is true. There can be no true basis of comparison between the cost of manufacture of American-made goods and Japan-made products, as the latter will not be just like the American products. They will be inferior. This must be so until, through education derived from years of experience, with close observation of machinery, materials, and products, the Japanese become good judges of style, adaptability to purpose, and quality.

Japan may eventually build its own locomotives, ships, railroads, and labor-performing machinery, and take possession of Asiatic markets, but it has not done so yet. By the time its progress in imitative development has brought it abreast with the development of these industries as they exist in the United States in 1896, the progress made by American inventive genius and creative skill will leave the gap be-

tween Japanese and American capabilities and achievements in the industrial world nearly as great as it is now.

The Japanese do right in erecting their own cotton mills and steel plants, and in building their own locomotives and ships. It is their duty to do for themselves the best they can, but their industries can have little effect on American home markets or export trade. They may make textiles and take less from Manchester and New England, but to vanquish America they must produce the raw material. They may in time make steel, and become less dependent on America, Germany, and England. They insist that they have all the iron they need, but, as a matter of fact, they have developed no deposits of a high character, though their country may be full of it. Their output in these industries may be greater than the requirements of their domestic trade, and may enter the markets of China and India, furnishing both America and England a new competitor in the orient. Such changes are always going on, but the sovereignty of trade rests with those that possess the widest range of natural resources and the highest degree of inventive genius and productive skill. These are the real factors in commercial competition. America possesses vast natural resources that have not been tapped; in inventive genius and skill it is out-ranked by none; its power of achievement and leadership is assured.

The Japanese are not without evidence of the truth of these statements. American enterprise in Japan is becoming aggressive. The excellence and superiority of American products are gradually making an indelible impress on the Japanese mind, and so winning their way to public favor. Their appreciation of American mining machinery is becoming pronounced; the American locomotive is making an enviable record among them; American machinery for manufacturing silk is doing work which they cannot duplicate in other ways; and numberless mechanical devices are causing them to understand that industrial problems are solved, not by imitation, but by invention.

Looking still deeper into the question, it is seen that Japan is indulging the expectation of being able to sell cotton sheeting and prints in American markets. The cotton it buys in America costs about twenty cents a pound at the door of its factories. It is a long voyage to take cotton from the fields of America to Japan, there manufacture it into sheeting, and then send it back to America for consumption, especially if Japan's merchants make London their entry port to America. This is the false system of economy that England has pursued ever since it became a manufacturing nation and is likely to pursue to its death.

The lack of the power of discrimination and sound judgment is a fatal weakness in an imitator. He copies the faults as well as the excellences of his model. It is evident that Japan is making England its

model, and is following it closely. The Japanese appear not to perceive that the economic system which England has pursued, and is pursuing, is to-day its greatest source of weakness. They do not see that England has passed the zenith of its commercial prestige, and is being worsted by one nation or another in every market in the world. They make no account of the fact that the southern States of America have learned the economic lessons taught by unwritten laws, and are building cotton factories amid their cotton fields, where labor-performing machinery, under the supervision of intelligent, free workmen, is bringing the labor cost of products below any point that can be touched by the cheap labor of the Orient.

The Japanese abandon their own export trade to the United States, which is ten times more than it is to England, and attempt to establish their commercial supremacy by trying to compete with England for the carrying trade of what they buy, as though industrial importance depended upon purchases instead of sales.

Japan is selling ten times as much to the United States as to England, and is buying five times as much from England as from the United States. This fact is indisputable evidence that Japan should develop its merchant marine by establishing lines to the United States, or that the United States should monopolize the carrying-trade of the Pacific by establishing lines of its own in the interest of its exports to the Orient. Since Japan has abandoned the field, it should be at once occupied by America, so that the opportunity will never again come to the dazed imitators of England in commercial invasion.

Modern Japan is making tireless and persistent efforts to free itself from dependence on foreign producers. This ideal partakes of the narrowness of oriental exclusiveness. It is a false guide. It lacks breadth and vital force. It cannot make a nation really great. The effort of every nation should be to produce all things for which the climate, soil, and waters of its country furnish *superior natural resources and advantages*, and to buy from others everything for the production of which they are better provided. This policy will keep a nation in cordial commercial touch with all the world.

Europe may indulge in a scare, induced by Japan's proposal to invade the markets of the world, but America can take no part in it. It is the policy of European countries to seek economic advantages through a meager standard of living that admits of low-priced labor. It is the proud policy of America to seek economic advantages through a standard of living sufficiently high to admit of the fullest development of the energies, skill, and genius of its workmen,—a standard of living that demands the highest wages paid anywhere in the world, but which inspires and satisfies hope, induces inventive gen-

ius and creative skill, and equips men *to devise and operate labor-performing machinery* by means of which American products, per dollar of labor cost, are the cheapest in the world.

In the last analysis, the true strength of a nation is in the intelligence of its people Nature has created no new resources in America since the red race vanished and a white race took possession. It has created no new resources in Japan from the beginning of its traditions until now. The economic differences in these countries, between their present and their past, have been wrought by growing intelligence in the use of natural resources that have always existed, waiting man's ability to utilize them. The greatest economic force is intelligence. Next to it stands natural supplies. These factors create and limit the purchasing power of a people. Following, but of equal importance, are population and extent of territory. The magnitude of these determine the limit of a nation's home market and its ability to resist pressure from foreign trade and to expand its commerce into foreign countries. Where the demand of the home market is sufficiently large to sustain an output great enough to enable producers to profit by all economies and mechanical advantages, and where the largest concentrations of capital, labor, and mechanical power are employed, an industrial momentum is created that may easily overleap the national boundary, and invade the markets of the world.

The extent of a home market is measured with sufficient accuracy by the purchasing power of its people. According to the census reports of the United States, the average yearly income of its wage-earners was: for 1860, $289; for 1870, $302; for 1880, $347; for 1890, $485. Estimating one wage-earner to each five persons, and his income at the average given above, the purchasing power of the wage-earners of the United States was: for 1860, $1,791,800,000; for 1870, $2,295,200,000; for 1880, $3,470,000,000; for 1890, $6,984,000,000.

An idea of the resistless momentum this enormous purchasing power must give to the industries of the United States may be conceived by considering that its increase from 1880 to 1890 was $3,514,000,000, and that the combined imports and exports of the United Kingdom of Great Britain for 1894 were $3,413,300,000,—a sum $100,700,000 less than the increase in wages in the United States from 1880 to 1890, and not equal to one-half of the wage-payments in 1890. The intelligence, natural resources, and purchasing power of the home market of the United States sustain its industries on a scale of operations which enables its manufactures to take full advantage of every known economy, and makes successful competition with them by smaller producers impossible.

Viewed in this light, the low-priced labor of Japan, which has been cited as its greatest competing advantage, is its greatest source of weakness. Such labor cannot be intelligent, skilful, and effective in the highest degree. On the one hand it limits competitive force by degrading quality and quantity of output, and on the other hand it destroys the foundation of industry by reducing the home market to the smallest possible volume. If the report is true that skilled labor in Japan is paid but twenty-five cents a day, and if we generously estimate all labor as "skilled" and earning the daily wage thirty days in every month, the annual income of the wage-earner is shown to be but $90. Taking the population at 42,000,000 and allowing one wage-earner for every five persons, the purchasing power of the wage-earners is $756,000,000,—about ten per cent. of the purchasing power of the wage-earners of the United States. A very respectable power, but not one calculated to cause Americans to be anxious.

This examination of the subject leads to the conclusion that the growth of intelligence in Japan will increase wages, and thus increase its purchasing power, causing the absorption of its industrial energies in supplying its home market, and neutralizing in a marked degree its power to invade the world's markets. If this be true, Japan, instead of becoming an increasing competitor of American manufacturers, will become an increasing purchaser of American products, not only on account of its increased purchasing power, but also on account of the fact that its growing intelligence will cause it to model its economic policy on the lines pursued by the United States, and to better understand and appreciate the advantages it can gain by purchasing as largely as possible from the United States whatever it needs to import.

The volume of Japan's exports to the United States will not increase as rapidly as the volume of its imports from the United States. If this conclusion is correct, Japan is a promising field for American exporters to cultivate.

A PRACTICAL EXPOSITION OF ELECTRIC LIGHTING.

A DISCUSSION OF PROF. CROCKER'S RECENT BOOK.

By Wm. A. Anthony.

FOR a long time there has been wanted a work that should give a comprehensive survey of the whole field that the electrical engineer has to cover when he undertakes the design of an electric-lighting plant, and it is not too much to say that Professor Crocker has succeeded admirably in supplying that want in his work.

What the engineer wants is a plain and concise statement of the results of experience, or of abstruse theoretical investigations which he cannot, for want of time or training, follow out for himself. He is already acquainted with elementary facts and theories, or can find these fully given in numerous existing works. It is well, therefore, that elementary matters are not allowed to lumber up the work. The writer has now in mind works on electric lighting which begin with the attraction of light bodies by amber, and carry the reader through chapter after chapter of the most elementary phenomena to be found described in every college text-book. In the work under review only those elementary facts and principles which have a direct bearing on the subjects under discussion are stated.

The introductory chapter contains a statement of the advantages and disadvantages of the electric light, the cost compared to gas, etc. This is followed by a brief history of its development. I cannot agree with what is said in this chapter in relation to the early views as to the subdivision of the electric light. The subdivision of the electric *current* was perfectly well understood long before the electric light was more than an accessory to lecture demonstrations. Before 1870 the subject was fully discussed in college text-books, and previous to that date I had given questions for examination in college classes requiring the determination of the currents flowing in several conductors in multiple arc. Given a practical incandescent lamp, it was perfectly well understood by those fully acquainted with the science in 1876-7 that such lamps could be run from one source without interfering with each other. But the electric light of that period was the *arc* light. There were practical difficulties in the way of making arc-light regulators that would work successfully from one source, but I do not know that it was ever thought to be theoretically, or even practically, impossible to do this. By the term "subdivision" of the

electric light at that period was not meant the supply of several lamps from one source, but literally the subdivision of the *light*. The arc light was a very powerful source of illumination,—far too powerful for use in small areas, indoors. It was desirable to subdivide it into smaller units comparable in illuminating power to single gas jets; but attempts to make small arc lights showed that the smaller light could be obtained only at a proportionally larger expenditure of power.

This was in accordance with the well-known fact that small gas jets give much less light in proportion to the gas consumed than large ones, and led to the statement by some writers that it was theoretically impossible to subdivide the electric *light* and maintain the efficiency of the arc lamp. Whether theoretically impossible or not, this result has never been accomplished.

In the account given of the early Edison apparatus, the author states that the Edison armature did not have more than one-fifth or one-tenth the resistance of previous machines. This is true of some previous machines that were made for a totally different purpose, but machines had been made prior to 1878 having low-resistance armatures. One designed by me and built in 1875 gave two hundred volts with an armature resistance of half an ohm, or one hundred volts with a resistance of one-eighth ohm. In the latter case the machine had a capacity of forty amperes. This machine was described in the *American Journal of Science* in 1876.

In referring to the Brush and to the Weston systems of arc lighting, the author states by implication that the former had, and the latter had not, a satisfactory current-regulator. According to my own observation at that time, exactly the contrary is true. Indeed, I personally knew of Weston arc-light plants in the early eighties in which a regulator *automatically* maintained a constant current when lamps were switched on or off, while he had not known at that time of a Brush plant in which the current was not adjusted by the operator, usually by means of a wooden wedge under the regulator lever. The difficulty with the Weston system was not with the regulator, but with the "short-arc" twenty-ampere lamps, which have never given the same satisfaction as the "long-arc" lamps.

In the chapter relating to general units and measures the author's remarks as to the use of the metrical and English systems are eminently just and timely. We in this country shall undoubtedly for a long time to come use feet and inches in laying out the dimensions of machines, and, this being true, the writer cannot see anything unscientific in the use of the units and coefficients introduced by Kapp for the computation of magnetic circuits. Kapp's system has been ridiculed and maligned, but it seems to me that there is good reason for every unit and

coefficient that he proposed; and, having all those at hand, it seems absurd for the American engineer to reduce to centimeters the dimensions of his magnetic circuit, which are given on his drawings in inches, for the sake of using another set of coefficients involving precisely the same difficulties in computation. The table of coefficients for reduction of French to English measures and *vice versa* is more complete than I have seen elsewhere, and will be found extremely useful.

In the chapter upon possible sources of electrical energy the author does well to point out so clearly the theoretical limitations to the efficiency of the steam engine. The second law of thermo-dynamics is so little understood and so generally ignored by practical engineers that its teaching needs to be set before them on every occasion in the most unmistakable language. It is a very common statement—to be found in periodical literature from writers who ought to know better— that the steam engine is a very wasteful machine. One writer said it was a "disgrace to the nineteenth century." The fact is that the steam engine is a very fairly efficient machine. As well say that a water-wheel is a very wasteful machine because of the small power derived, when, from conditions beyond our control, we are unable to use more than a small fraction of the total fall of water. This is exactly the case with the steam engine. Conditions *are* such that we cannot utilize more than a small fraction of the total fall of temperature. Of the available energy supplied to it the engine returns a very creditable fraction.

I am glad to see also the ether and carbon disulphid fallacies pointed out.

With reference to thermo-electric batteries, one great obstacle in the way of high efficiency is the fact that the materials making up the battery are necessarily fair conductors of heat. When, therefore, a high temperature is maintained at one junction of a thermo-electric couple and a low temperature at the other, heat is conducted along the element and must be carried away by cooling arrangements at the cold junction. This heat is entirely wasted, and, in all materials available for thermo-electric pairs, the conducting power is so high that the heat so conducted away is a very large proportion of the total heat consumed.

In the chapter on steam boilers the several types are briefly described. More might have been said of the relative advantages of water-tube as compared with cylinder boilers.

In referring to mechanical stokers, the author states that one objection to their use is "that they feed without regard to the demands upon the boiler." But all mechanical stokers are so arranged that the feed may be adjustable by the attendant, and in some the feed is controlled automatically by the steam pressure.

A very important matter in the economy of large central stations is the handling of the fuel and carrying away of the ashes. Some space might very profitably have been devoted to a description of some of the methods by which this is done, and a discussion of the advantages derived.

Chapter X, in relation to the steam engine, contains much valuable information. The remarks upon fly-wheel construction are especially timely. In view of the disastrous fly-wheel accidents that have occurred in recent years, engineers cannot give too much attention to this subject. The remark has been made that all such accidents have occurred with engines of the Corliss type. These are slow-speed engines, having usually an early point of cut-off. They must necessarily have very large and massive fly-wheels. During the early part of the stroke the arms are bent in one direction by the accelerating action of the steam; during the latter part of the stroke they are bent in the opposite direction, from the fact that the momentum of the fly-wheel then carries the load. This alternate tendency to bend back and forth is, to be sure, normal, as the author states, but its effect must be considerable, as is evident from the fact that in all such engines there is a variation of speed during each half-revolution sufficient to produce a marked effect upon the brilliancy of incandescent lamps.

When the fly-wheel of the engine is the driving-wheel, the inertia of the rim carries the load without strain upon the arms during the latter part of the stroke, while during the earlier part of the stroke the arms must sustain the entire strain due to the full action of the steam upon the piston. In case of a sudden increase of load or a short circuit, the strain on the arms would be very little greater, since there is nothing to produce strain upon the arms except the steam pressure and the very small effect due to inertia of the shaft and reciprocating parts when the rim of the fly-wheel is retarded. Now, fly-wheel accidents have been frequent in the case of engines belted from the fly-wheel, where the effect of heavy overloads and short circuits would be a minimum. It seems to me that, since these accidents have been confined to long-stroke, slow-speed, early-cut-off engines, too little allowance has been made, in the design of fly-wheels, for the cumulative effect of these continually-alternating strains.

In discussing the desirability of using condensing engines, the author states that it would probably be easier and cheaper to design the boiler for a higher pressure than to have the complication of a condenser. This may be true, but it must be understood that, with an engine working at one hundred pounds' pressure, to obtain by increasing the boiler pressure the same gain in *efficiency* which could be obtained by adding a condenser, the boiler pressure would need to

be increased to two hundred and fifty pounds, which would necessitate building an entirely new engine. That such an increase of pressure is required will appear from the expression for efficiency

$$\frac{T-T_1}{T}$$

For steam at 100 lbs..... $T=338$ Fahr.
In a non-condensing engine..... $T=212$

$$\text{Efficiency} \ldots\ldots = \frac{338-212}{338+460} = \frac{126}{798} = 15.8\%$$

As a condensing engine..... $T_1=162$

$$\text{Efficiency} \ldots\ldots \quad \frac{338-162}{798} = \frac{176}{798} = 22.1\%$$

To obtain the same efficiency as a non-condensing engine, we must have

$$\frac{t-212}{t+60\ 4} = .221$$
$$t=400^\circ$$

which corresponds to a steam pressure of about two hundred and fifty pounds.

In the discussion of valves and valve-gear a little more might have been said of the advantages of separate exhaust and admission valves. With a single slide-valve, as used in most high-speed engines, a variable compression, as well as a variable cut-off, is obtained by the action of the governor under varying load. For the smoothest and best action of the engine the compression should be the same for all loads, and this can best be obtained by using a separate valve actuated by a fixed eccentric for the exhaust. In some of the larger sizes of the Straight Line engine this method is employed.

In Chapter XV are discussed the various methods of coupling dynamos to prime movers. The plan of connecting the dynamo directly to the engine is to be recommended for large machines where the speed of the dynamo is comparable to that of the engine, but I am unable to see the advantage of direct coupling of the smaller sizes,—say, from 75 k. w. down,—except where the space available prohibits the use of belts. A 50-k. w. dynamo may just as well as not run at nine hundred revolutions, while an engine of similar power will run at only three hundred revolutions. For that capacity, therefore, a very much larger and more expensive dynamo must be built for direct coupling than for belting.

The statement on page 242 that rubber belting costs two or three times as much as an equivalent in leather belting must be a mistake, since the first cost of even six-ply rubber belting is much less than that of double leather dynamo belting of the same width.

In Chapter XVI, upon gearing, the author fails to mention one plan of hydraulic gearing that has been proposed, though never to my knowledge tried on a practical scale. It consists of a pump operated from the driving axle and actuating three hydraulic motors on the driven axle. These motors have different capacities, and are so proportioned that, when coupled, all three in multiple, in pairs of two in multiple, and then singly in the order of size, they give seven different speeds, varying by nearly uniform steps. This seems to be a practical arrangement, though perhaps an expensive one, and to involve less mechanical difficulties than a variable stroke pump.

In Chapter XVII the principles and construction of dynamos are discussed. The author does well to point out clearly the fact that there is no royal road to the design of electrical machinery. There is no such thing as framing rules or devising a set of formulæ by which a dynamo for any particular purpose can be designed. A dozen different machines might be built, all of which would serve a required purpose, but which, nevertheless, would differ from each other in form, dimensions, number of poles, speed, etc. ; all might be fair machines, and yet none of them might *best* serve the purpose in view. The development of the best design requires a careful study of the possible forms and dimensions, and finally depends upon an exercise of judgment to be acquired only by experience.

There is probably no branch of engineering in which the problems to be solved involve so many unknown quantities with so few equations to connect them, and which, therefore, require so many arbitrary assumptions in order that the problem may be solved. The design of electrical machinery for any new use should be trusted only to the experienced engineer, and even he would find it necessary to vary his assumptions and make several solutions of the problem before he could be sure that he had hit upon the best design.

Sometimes several considerations are involved in the determination of one or two unknown quantities, different results being arrived at according as one or another condition is made the basis of the solution. Here again the selection of the best value must depend upon an exercise of judgment.

As an illustration, in the drum or Siemens' armature the least resistance would be obtained by making the coils circular, but this would require a spherical armature core, which for many reasons would be undesirable. The next best form would be a core whose length was equal to its diameter, which would require square coils ; but the hysteresis losses in such a case would be greater than in one having the same sectional area, but a diameter less than its length. Again, an armature having a diameter *greater* than its length might be better

suited than the other forms to the speed and winding. It is an engineer's province to take all these things into consideration, and endeavor to hit the happy medium best fulfilling all the conditions.

I have not seen elsewhere in so small a space so much general information upon dynamo construction as is contained in this chapter. It is almost wholly a statement of facts and principles without attempt at logical deduction. In one or two cases, where a reason is given, it would have been as well to leave the matter with the mere statement of the fact. For instance, on page 269, under magneto-motive force, the statement is made that, "strictly speaking, the C. G. S. value of M. M. F. is 1.237 times the ampere turns." The author then adds: "This is because the difference of magnetic potential on opposite sides of a turn of wire is equal to 4π times the current flowing in the wire." . . . To one who understands what C. G. S. values and magnetic potentials are the explanation is unnecessary; to one who does not, it is meaningless, as no definition or explanation of these terms had previously been given in the work.

On page 304, near the middle, is a misprint. μ is the quotient of B by H,—not of H by B, as the text has it.

The chapter upon the practical management of dynamos contains many hints, valuable to the dynamo attendant, as to the causes and probable remedies of dynamo troubles. Every dynamo attendant should make himself familiar with the matters treated in this chapter. It must be said, however, that no amount of empirical instruction can serve the purpose of a clear understanding of the scientific principles upon which the operation of the dynamo and the distribution of electrical energy depend, and intelligence in applying this knowledge when occasion arises. I call to mind an instance in which an electrician was sent from a factory a distance of more than a thousand miles to find the trouble in a machine which failed to work; when he reached his destination, he found the difficulty to be a connection so obviously wrong that any one having the least theoretical knowledge or practical experience should have seen and corrected it. All he did was to change the plug of a plug-switch from one hole to another, when the machine started off all right.

In that part of this chapter relating to diseases of dynamos, some of the causes given under some of the headings seem very inadequate. For instance, under the head, "Speed too low," are given "Short circuit in armature," "Armature strikes pole pieces," "Shaft does not revolve freely." If, from either of these causes, power enough were consumed to materially reduce the speed of the armature, effects would be produced that would be far more apparent, and call for more energetic action on the part of the attendant than

would reduction of speed. The cause of reduced speed as an apparent "disease" would be looked for in a slack belt, a low steam pressure, or a faulty governor.

The chapters upon the construction and use of accumulators are timely and important. It seems a little strange, in view of the extensive use of accumulators in Europe, that they should have been so little used in this country. The reason seems to have been that in this country capital is worth more, and users of electric plants would not invest the money necessary to instal a first-class accumulator plant. In the attempt to reduce the first cost, plates were made thin and light, and batteries were installed for service which, if any regard were had for a reasonable life, was far beyond their capacities.

There is no question that an accumulator plant may be constructed, installed, and operated under conditions that will bring the deterioration within five per cent. per annum. Such a plant would, no doubt, be a very costly one, but there are conditions under which it might be economy to use it. In a fairly light office-building, for instance, the heavy load will not continue more than three or four hours each day. A battery might take two-fifths of this, reducing the necessary dynamo and engine capacity by this amount, and making it possible to reduce the running time of the dynamo plant and the time of attendance to ten hours per day, during which time the plant could be run at its most economical load. The saving in operating expenses would, in that case, be very considerable, and might more than pay interest on the extra cost of the plant.

As has been already stated, accumulators, as first introduced into this country, were very short lived and very unsatisfactory. It was with such as these that the experiments upon electric traction and train lighting were made, in which, as stated by the author, the life of the batteries sometimes did not exceed one year. The batteries at present furnished by the Electric Storage Battery Co. would certainly give better results than this. It is well that these accumulators are being tested on a large scale, as at the Edison station in Boston and elsewhere.

The remaining chapters of the work relate to switchboards, instruments, and lightning-arresters. Very little is said of switchboards as a whole, that subject being left for further treatment in the second volume. Switches, instruments, and lightning-arresters are, however, briefly described, the conditions of use and the advantages and disadvantages of the different forms being briefly given.

The work is well printed and fully illustrated, and will be found a valuable addition to the library of any one interested in the installation or management of electric-lighting plants.

REVIEW OF THE ENGINEERING PRESS

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INTRODUCTORY

THE aim in this Review and Index is, (1) to give concisely written expert reviews of those articles of the month which are deemed of most importance ; (2) to supply a descriptive Index to the leading articles published currently in the engineering, architectural and scientific press of the United States, Great Britain and the British Colonies; and (3) to afford, through our Clipping Bureau, a means whereby all or any portion of this literature may be easily procured.

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Yale Scientific Monthly The. *m.* $2.50 New Haven.

ARCHITECTURE & BUILDING

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The Question of Fire-Proofing.

THE ENGINEERING NEWS for April 9 and 16 contains a valuable paper by Mr. H. B. Seely, entitled "The Art of Fire-Proofing," which reviews the practical results of fire-proofing in steel construction, as shown in fires in large office-buildings, and points out what should be done to improve the efficiency of our building methods in this respect. Mr. Seely does not hesitate to say that much additional experimental knowledge is necessary before the art of fire-proofing can be considered as standing on a firm basis, and he presents a strong plea for further tests and experiments under competent supervision.

Tests for fire proofing are, of course, exceedingly expensive; yet it is nothing short of astonishing that architects should, year after year, continue to use constructive methods of whose practical utility they know very little, and of whose further development they know nothing at all. A large building is a most costly thing to experiment upon, yet this is just what many architects do with the structures committed to their care when they use methods of construction and of fire-proofing without full experimental demonstration of their value and efficiency.

In commenting on the matter editorially, the *Engineering News*, in a long article which adds nothing at all to the knowledge of the subject, summarizes the dangers from fire as follows: "(1) The most serious danger to the integrity of a building by fire lies in the distortion of the steel frame by heat; (2) the most dangerous defect for a fire-proofing is easy disruption by fire and water, thus leaving the framework practically bare, exposed to the direct action of the flames and affording openings for the spread of the fire; (3) fire records show disruption under fire and water to be the most noticeable defect of the fire-proofing materials commonly used to-day."

In concluding the discussion Mr. Seely says: "Fire-proof construction, as distinguished from incombustible construction, is necessary, if the integrity of a building is to be preserved in very ordinary fires. The usual methods of fire-proofing by the materials of construction are defective from the fact that the protecting value of most materials so used is destroyed by their rupture while heated and subjected to the attack of water. The most promising line of improvement is the use of a covering of material not easily damaged by the combined attack of heat and water, to protect the more sensitive constructive fire-proofing from such attack.

"The facts stand that in every fire of any size recorded in a fire-proof building the building was found vulnerable to the flames; the constructive tiling cracked and broke, the adjacent metal framework was injured, the flames spread by means of doors and stairways and broken tile partitions."

All this is true enough; and it is equally true, as Mr. Seely points out, that our absolute knowledge is not great; nevertheless, everyone must agree that, even with imperfect knowledge and imperfect methods, much has been done to increase the safety of our so-called fire-proof buildings.

Fire-Proof Flooring Experiments.

THE subject of fire-proof flooring is of the first importance in modern building, and it is receiving very careful attention, with reference both to materials and to construction. Since our last number went to press an account of important experiments made by Mr. Howard Constable, at Perth Amboy (*Engineering News*, May 14), and an illustrated paper entitled "Fire-Proof Floors in Modern Buildings," by F. L. Douglas (*The Year Book of the Society of Engineers*, 1896), have been added to the literature of the subject.

Mr. Constable's experiments are described in *Engineering News* by Mr. James

C. Rossi, C. E., who regards the test of a fire-proof floor made at Perth Amboy, N. J., as particularly interesting. The floor tested "was of larger size than usual, and represented an entirely completed floor and ceiling ready for use, with a distributed load of 170 pounds per square foot. It was subjected to a fire of unusual intensity for over two hours, the temperature at the ceiling level reaching over 2,000° by the pyrometer. It also gives some comparative idea of the resistance to fire and water of common plaster, Portland cement, and patent plaster, as well as the transmission of heat through these various materials, and the strength, and fire- and water-resisting qualities, of hard and porous terra cotta arches."

Engravings from photographs presented with Mr. Rossi's communication show that "the terra-cotta arches were uninjured, and merely needed replastering, the common plaster with which they were covered being mostly washed away. When the arch blocks forming the floor were finally removed, they had to be hammered down, and had retained their original strength."

They also indicate that Portland cement stood well, while, under similar conditions, patent plaster was pretty well destroyed by fire and water.

"The test was unusually severe, because the room was piled over 4 feet deep with dry pine and oak. It should be added that the room was fitted with an inlet for air at each lower corner, and an outlet stack at each upper corner. The floors were covered with a grillage of brick, so that the air could get under all parts of the firewood. Iron beams were put in the brickwork of the front and rear 12-inch walls, and were protected in the front wall by 4 inches of common brick and ⅞ inch of plastering, and in the rear wall by 2 inches of porous terra-cotta. None of these beams disrupted the brickwork, nor was their temperature at the center raised to over 160°."

Referring to a system of fire-proofing discussed in *Engineering News*, July 18, 1895, Mr. Rossi thinks that the results of Mr. Constable's tests do not "warrant the unqualified advocacy of plaster nor the sweeping condemnation of terra-cotta arches."

The repairs needed after Mr. Constable's test, as stated by Mr. Rossi, were the smallest possible,—"simply replastering the surface, and consequently much less than having to replace wire lath, etc. The fact that the load has remained on for over two weeks since the fire, and was increased by being soaked while throwing water all over it to cool down the brickwork, is a proof of the great strength of the terra-cotta arches as well as their resistance to fire and water, and their economy in repairs."

Mr. Rossi intimates that the "reasons for some of the failures of terra-cotta arches will be found in poor construction and materials"; that proper design of the hollow tile for arch-blocks is not always secured; and that inferior material and careless laying are also causes of failure.

"It will be found a very difficult matter to prove that burnt clay, when properly treated and applied, is not the best fire-resisting material for building work, and I may say that I believe Mr. Constable has approached this new and half-developed art in the right way by a most extensive and elaborate series of tests of materials, so as to know precisely their intrinsic and comparative merits. A close investigation into the question of usual and unusual temperature will enable one to judge of and compare the various tests that have been and are being made, and to form an opinion upon them.

"The results of transmission of heat through cement, terra-cotta, and brick were interesting, and, I believe, show that some of the results feared by Mr. Seely from expansion are not quite as great as one would infer.

"I would also refer to the point Mr. Constable raised in connection with the Bleecker street fire, which was that a large open space between the ceiling and the floor might be readily converted in many buildings into a reverbatory flue supplying heated air to the room above, thereby intensifying the heat so that no materials could be expected to withstand it. That is a well-known principle in securing intense heat in a furnace."

Some Western Architects.

AN extra number of *The Architectural Record* is given up to "A Critique" of the work of notable western architects—Adler & Sullivan, D. H. Burnham & Co., and Henry Ives Cobb,—by Mr. Montgomery Schuyler. It is superbly illustrated with a host of photographs, charmingly printed in the usual style of this periodical; but, notwithstanding the fact that a very large proportion of the work of all these architects, and especially of the two firms, has been great commercial buildings, not a single plan or structural diagram is presented. For a periodical devoted to architecture to thus slight the very basis of the art is quite as sensible as the publishing of a book on anatomy without an illustration of a skeleton!

Than Mr. Schuyler there are few more competent architectural writers in America. He generally has something to say, and says it in a most delightful and readable manner. One may not always agree with him, but his skill of presentation is unquestionably great. If he himself is open to criticism, it is that he suffers somewhat from an imperfect point of view. His study of these western architects is a case in point. In treating of the work of Messrs. Adler & Sullivan, he gives most of his space to a consideration of Mr. Sullivan's extraordinary gifts as an artist. Yet, while this artist's most conspicuous triumphs have been gained in commercial architecture, Mr. Schuyler heaves a sigh of relief when he has passed them and can say a word or two on Mr. Sullivan's smaller buildings. These, by the way, are not so well known as his larger work, and the illustrations of them which accompany this article will be eagerly welcomed by his admirers. If Mr. Schuyler had thoroughly absorbed the spirit that animated his subject in his designs, he would not have hastened from high buildings to low ones, and in this failure to put himself in the architect's place is the writer's chief misfortune.

The author of this monograph is wise not to draw comparisons between the buildings of the different architects he considers. Messrs. Adler, Sullivan, Burnham, and Cobb are indeed representative Chicago architects, but it is impossible to imagine a greater contrast than exists between their work. In Mr. Sullivan, a man of striking originality and power, whose fine artistic perception has been developed to the utmost, we have the artist unmistakably. Mr. Burnham pretends to little of this quality, though the one building with which his name is most intimately associated—the Monadnock—is one of the most successful high buildings in America; of his well-known and thoroughly-proved qualities as administrator it is not necessary to speak, but it is these qualities that have won him the renown he has, and have made him the notable figure he is in Chicago architecture.

It is, perhaps, a significant fact that, notwithstanding the fame of these two firms, the number of their undertakings has been relatively small. Artistically, of course, there can be no comparison between them, for the work of Mr. Burnham makes no pretence to that artistic originality which is so notable in the productions of Mr. Sullivan. But with Mr. Cobb we have an architect of a different sort. Many of his buildings are both original and beautiful, though they do not bear that impress of refined thought which is so characteristic of Mr. Sullivan's. But, unlike either of his brothers, Mr. Cobb's work has been conducted on the largest scale. His buildings are almost as the sand of the sea for number, and not a few of his undertakings, notably the University of Chicago, have been produced, and in a sense completed, within a fraction of the time that might justly have been given to them. It is fortunate that, with this rapid production, there has been a relatively high standard of architectural excellence; his work, without rising to the rank of great, is generally pleasing, and, in some cases, has been decidedly interesting and original. Of the three men Mr. Cobb is perhaps the most typically American in the magnitude and variety of his undertakings, and typically American also in the average quality of his successes. He is typical, moreover, of that spirit for large enterprises which those outside of Chicago

consider characteristic of that city. But whether these are the qualities to be considered in architecture those that come after us will be better able to judge.

Radiator and Box-Coil Connections Under the Mills System.

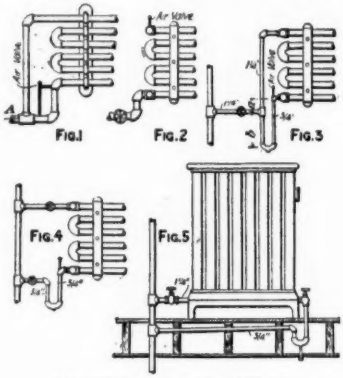
MR. EDGAR KIDWELL writes to *The Engineering Record* (April 25) describing and illustrating a method of making radiator and box-coil connections, which, he says, has been applied in Engineering Hall, at the Michigan Mining School. Referring to a discussion in a previous issue, by Mr. E. E. Magovern, and a statement by the latter of defects in the usual connection (Fig. 1) and in the connection (Fig. 2) recommended by Mr. Magovern, he confirms the defects in the connection shown in Fig. 1, but considers that shown in Fig. 2 as also defective, except when the coils are small and the steam pressure very steady.

"In case of coils containing 60 to 85 square feet of radiating surface, there would be such violent pounding under ordinary fluctuations of steam pressure that these coils had all to be shut off. The two-pipe system could not be permitted, and it was a question of making these coils work on the one-pipe system, or else replacing them with cast-iron radiators.

"Figure 3 shows the result of the experiments made. The writer is familiar with the use of water seals in heating, and has himself often used them, but the precise arrangements here described are new to him, though doubtless known to others. It is evident that the water seal causes the arrangement to work exactly as in a two-pipe system, except that the return water flows from the top along the bottom of the horizontal connecting pipe. The drawing shows sizes of pipe used for coils two to three pipes deep, eight high, and 8 to 11 feet long, all 1¼-inch pipe. A 1½-inch supply would be better, but in this case 1¼ was used, owing to size of outlet in the riser.

"The only precaution to observe in this connection is that the distance *a* must be greater than the head of water equivalent to the maximum drop of pressure between the supply and return pipe of the coil. The writer has found that in all his work a distance of 7½ inches is ample. Distance *b* should be not less than this; in the work under question it was anything from 7½ to 14 inches. Gate valves must be used; globes will not answer. If the fitting is well done, and the supply pipe has a little fall, the radiator will be noiseless under any changes of steam pressure.

"The writer does not like to have steam



RADIATOR AND BOX-COIL CONNECTIONS.

and water going in opposite directions in horizontal pipes, unless they are very short; hence has designed connection as in Fig. 4, to be used when radiator is more than 3 feet from the riser. The dimensions of the trap should, of course, be the same as in Fig. 3. When it is possible to use this design, the writer prefers it to Fig. 3, even when coil is quite near the riser.

"Some object to the one-pipe system because of the pounding when a radiator is turned on, and the boiling or gurgling sound frequently heard when the radiator is in use. The writer has had to consider cases where such troubles existed, and it was decided to apply the principle underlying Figs. 3 and 4. Figure 5 shows the result of the experiments, and it completely cures the evils. Everything works as in a two-pipe system; water and steam go the same way, the circulation is rapid, and the radiator is noiseless.

"A return bend with ¾-inch back outlet was used for bottom of traps, and into outlet was screwed a capped nipple, or a bushing and petcock. These traps have

never given trouble, except in one case, where the fitter carelessly left in the pipes enough chips to plug up the bend.

"The writer has given the above connections two years' trial, and found them highly satisfactory, if the work is properly done. The scheme is superior to the two-pipe system, in so far as it is impossible to flood the radiator by leaving open the return valve. If this be done in Figs. 4 and 5, the steam pressure will drive the water in the trap up into the radiator, and make a very decided noise, before the party who closed the steam side can get very far away, and it thereby gives warning that the return is open. The writer considers this a valuable feature, as he has seen numerous cases where, in a two-pipe system, the flooding of radiators and consequent leakage around valve stems and through air valves has seriously damaged furnishings in houses, and books and apparatus in schools.

"In Engineering Hall, Michigan Mining School, cast radiators are used on the second floor, part of them with ordinary one-pipe connections, and part connected as in Fig. 5; on the first floor (shops and lavatories) coils are used, all connected as in Figs. 3 or 4; in the basement (shops) coils with regular two-pipe connections are used. The relative performances of these have been carefully watched, and the connections here described are in this case considered preferable to the others."

The High-Building Bill.

AT a recent meeting of the New York chapter of the American Institute of Architects, reported in *Architecture and Building* (May 23), there was a spirited discussion of the act to regulate the height of buildings in the city of New York, introduced in the senate of the State of New York by Senator Pavey. In this discussion many prominent architects took part, the meeting having been specially called to consider the bill.

Probably the remarks of Mr. Post on this occasion voice the feeling of the profession with reference to the extension of tall building better than anything else we can quote from the discussion. This well-known and influential architect remarked:

"I have built many of the high buildings in New York, and have on my table at the present time plans for several proposed new buildings in which my clients demand that they should be, in my opinion, abnormally high. I nevertheless believe it is my duty as a citizen, and as one represented in the advancement of architecture in our country as a fine art and the best interests of the city of New York, to advocate as strongly as possible the passage of a law restricting the height of buildings.

"I believe that it is necessary to the interests of the city, on account of its insular position and great length in proportion to its width, which necessitates to a large extent the concentration of trade, tha ourt buildings should be made taller than would be justified by purely esthetic principles; and therefore, in drawing the act known as the Pavey bill, I so arranged it that the height of the buildings would be about that of our tall structures before the introduction of steel-cage construction. The height of these buildings was limited by the amount of space occupied by the basement piers. With steel-cage construction it is limited by the amount of space which can be devoted to the necessary elevator plant. I have found by experience that one elevator will supply an adequate service for about fifty offices of an average size.

"The objections to very tall buildings are serious. If their construction could be limited to one in each block, occupying we will say one-quarter of its area, they might be considered as a necessary evil, but discriminating legislation in favor of certain pieces of property in the same section would be impossible. It is a fact which is proved by the practice of all our architects that the tendency is to make all new buildings extremely high. This can be stopped now by legislation before the city is irreparably damaged. If it is not stopped, the consequence must be disastrous, and redress will be almost impossible. The results of bacteriological investigation show that the evil microbes flourish and increase in damp, dark places, but that sunlight destroys their life.

"Our narrow streets, when lined with tall structures, will thus become unhealthy alleys, with an inadequate capacity for the passage of the crowds which will flow from these tall buildings, if occupied, for the capacity of the streets is already severely taxed at certain times of the day in the crowded districts by the tenants of the buildings; but, when our streets are so lined, the lower stories of the buildings will be no longer valuable for office or living purposes, and will be only fit for storage.

"The first effect of a law limiting the height of buildings would be doubtless to somewhat decrease the value of a relatively small number of large plats, but in my opinion it would increase the value of small holdings, and the ultimate result would be to increase largely the average value of property throughout the city by preventing the extreme concentration of trade and business in one or two localities.

"From an artistic point of view the gain to the city by the passage of such a law cannot be disputed, for, even if the principal façades of a building towering above the surrounding houses may be handsome, its plain brick masonry on ends and rear will always form a hideous mass. It can only be beautiful if treated as a tower, but such a façade would necessarily entirely lose its effect if connected continuously with another façade of approximately the same height. The filing of plans to enclose the American Surety Company tower on two sides by a building twenty-two stories high forms the best possible illustration of this last statement."

Mr. Constable, while concurring with the views expressed by Mr. Post, added that both the sewer and water-supply systems of the city will soon be overcrowded, if the erection of tall buildings be allowed to proceed without restriction. He fully agreed with the principle of limiting height on the basis of width of streets and graded ratio as proposed by Mr. Post. The bill was approved, with the qualification of some slight criticisms, by all who spoke at the meeting, and a resolution to that effect was passed.

Trade Catalogues.

AMONG the literature of heating and ventilation must be reckoned the trade catalogues issued by the leading houses engaged in this branch of engineering. Some of these contain excellent essays upon the principles of heating and ventilation. The practical experience of their authors gives them a special value, not characteristic of some treatises in which only the scientific side of the subject is dealt with.

This line of thought has been suggested by the careful examination of the catalogues of two prominent firms recently received at this office. One of these presents a line of boilers and heating appliances, for large and small buildings, which can be used either with or without forced circulation of air, and the other deals with appliances for heating and ventilating exclusively by the use of fan-blowers. By carefully perusing, and applying the principles and examples presented in these catalogues, an intelligent young engineer, without experience, but with good native sense and caution, could scarcely go far astray in planning even a somewhat difficult piece of heating and ventilating work.

THE ENGINEERING INDEX—1896.

Current Leading Articles on Architecture and Building and Allied Subjects in the American and English Architectural and Engineering Journals—See Introductory.

*5941. Domestic Architecture in Washington City. Ill. Glenn Brown (Showing a century's architectural development in the nation's capital as expressed in the private residence). Eng Mag–June. 3600 w.

5949. The Dedication of the New Site of Columbia University (A brief account of the dedication, with illustration of the library building, and progress made on other buildings to be erected). Science–May 8. 1100 w.

*5948. The Present Position of Architecture at the Royal Academy. F. Masey (Read before the British Architectural Assn Considering the real nature of the relationship of architects to the Royal Academy; the character of the benefits which they receive; whether there is just cause for dissatisfaction; and if so, what are the remedies Arch, Lond–May 1. 3500 w.

*5985. Stafford County Council Buildings (Descriptive). Brit Arch–May 1. 3000 w.

We supply copies of these articles. See introductory.

6073. The Effect of Fire on Fireproofing Materials. James C. Rossi (Results of a fire and water test made by Howard Constable upon a building at Perth Amboy, N. J. The test is particularly interesting as the floor tested was of a larger size than usual, and represented an entirely completed floor and ceiling ready for use with a distributed load of 170 lbs. per. sq. ft). Eng News-May 14. 800 w.

†6075. Fire-Proof Floors in Modern Buildings. F. L. Douglas (A discussion of fire proof floors. Considers hollow tile arches, concrete iron floors, metropolitan system, Melan system, Roebling system, Columbian system). Engineers' Year Book-Univ of Minn. 4300 w.

*6112. The Stadion at Athens (From a special correspondent to the London *Times*. Historical and descriptive). Arch, Lond-May 8. 1800 w.

†6131. Ninth Annual Exhibition of the Chicago Architectural Club. Peter B. Wight (An account of the exhibition, which is considered the best the club has ever held). In Arch-April. 2000 w.

†6132. A Story of Stone (This is one of a series of articles intended to present many interesting facts regarding stone, reviewed from a scientific standpoint, and with reference to its practical value in construction, etc). In Arch-April. 2000 w.

†6145. The Instruction in Architectural Drawing at Columbia College. William R. Ware (The first part treats mainly of tracing and copying, and is copiously illustrated). Sch of Mines Quar-April. Serial. 1st part. 4500 w.

†6146. The Treatment for Wind Pressure in Mill Construction. James L. Greenleaf (The term mill construction is here used to describe those cases of building in which iron or timber columns support the roof trusses and covering. The paper includes a preliminary discussion of the columns, and truss proper; detailed discussion of the columns and truss proper, with application to a particular example). Sch of Mines Quar-April. 9000 w.

*6173. The Architect's Use of Color. I. Halsey R. Ricardo. II. Christopher Whall (Papers read at the general meeting of the Royal Institute of British Architects, with discussion. The importance of studying materials and their possibilities in producing harmonious effects in architecture). Jour of Roy Inst of Brit Archs-April 23. 14000 w.

6181. The Ancient Cities of Yucatan (Historical and descriptive with illustrations of the peculiar architecture). Sci Am Sup-May 23. 3200 w.

6204 Discussion of the High-Building Bill (General discussion by the New York Chapter A. I. A.). Arch & Build-May 23. 2500 w.

6208. Truth in Architecture. W. E. Doran (Paper read before the Province of Quebec Association of Architects. Historical view revealing the state of civilization, manners, customs, etc., of the people. Also the development of a style that tells of the needs for which the building was intended, etc). Can Arch-May. Serial. 1st part. 2000 w.

*6244. Ribbed Vaults (Tracing the progress of vaulting, with the advantages peculiar to the different kinds, and references to some notable work). Arch, Lond-May 15. 2300 w.

*6255. Our Homes—As They Are and As They Ought to Be. John Balbirnie (Observations on the faults of close-pent houses of towns, with suggestions for improvement). Ill Car & Build-May 15. 2000 w.

*6263. The Resistance of Brickwork. C. H. Blackall (A review of the experiments recently made in England under the direction of the Royal Institute of Architects, with the object of determining the resistance to crushing of brick piers). Brickbuilder-May. 2800 w.

*6264. Mantels. A. Mason (The building of masonry mantels is considered. The necessity of following a drawing exactly and intelligently, etc). Brickbuilder-May. 1700 w.

6317. The New House for the American Society of Civil Engineers (Brief illustrated description). Eng News-May 28. 500 w.

†6366. The Sky Scrapers of Rome. Rololfo Lanciani (Historical account of the causes that led to increasing the height of buildings in Rome and of restrictions recorded, with many interesting facts connected with the height of buildings in ancient cities). N Am Rev-June. 3800 w.

†6371. The Tall Office Building Artistically Considered. Louis H. Sullivan, in *Lippincott's Mag.* for March (A study of the problem, and a support of the three part division as natural and significant). In Arch-May. 3500 w.

†6372. The Fisher Building, Chicago—A Building Without Walls (Illustrated description of this fireproof building). In Arch-May. 4500 w.

6381.—75 cts. The Roman Country House. A. D. F. Hamlin (The first part is a review of the habits of life which made the architecture and landscape of the Roman of more importance than the interiors, with illustrations and interesting information connected with the subject). Arch Rev-Vol. IV. No. II. Serial. 1st part. 2800 w.

6382. The Temple of Iyemitsu. C. T. Mathews (Illustrated description of this temple with remarks on Japanese architecture, and the difficulty of foreigners in understanding the art of this nation, because of a difference in the habit of mind). Am Arch-May 30. 2700 w.

*6383. Opera Houses and Theatres (Review of work by Edwin O. Sachs and Ernest A. E. Woodrow, with illustrations. A work for architects). Arch, Lond-May 22. 2800 w.

*6384. New Municipal Buildings, Croydon (Descriptive). Brit Arch-May 22. 6000 w.

*6403. Architecture in India. Nanaji Narayan Waslekar (The first part is an outline of the several phases of architecture as found in India. Subsequent parts will contain detailed descriptions of some of the principal structures). So Arch-May. 2000 w.

*6405. Masonic Temple, Montgomery, Ala. (Illustrated description). So Arch–May. 800 w.

*6406. The Model School-House. R. L. Jones (Calling attention to the essentials of a model school building and the wisdom of providing the same). So Arch–May. 3000 w.

†6133. South Calcutta Hospital, Bhowanipore (Detailed description of a suburban hospital, with elevation and sections). Ind Engng –May 2. 2000 w.

6446. The Commercial Cable Building (This building is between Broad and New Sts., New York. It was feared that sinking the caissons, to carry the foundations to bed-rock, would weaken adjacent foundations. The method used to reinforce them is described, with description of the foundations themselves, with general plan, elevation, and cross-section; also details of one of the caissons). R R Gaz–June 5. 1000 w.

6454. Shipping and Transit Needs of New York (Effects of a probable law, limiting the height of buildings in New York city, upon the future needs of transportation to outlying districts is discussed). Arch & Build–June 6. 1100 w.

6465. High-Wind Pressures at St. Louis (Editorial suggestions of availability of effects of the recent tornado in St. Louis, in the determination of wind pressures with reference to the probable results of similar storms upon high buildings and other structures). Eng Rec –June 6. 900 w.

6466. The Tenement-House Competition (The award made by the appointed committee is announced, with statement of conditions, and an abstract from an analysis of the plans as published in the *Tribune*). Eng Rec–June 6. 900 w.

6489. Bruges. George Spencer Morris (Descriptive account claiming the place to be of special interest to artists and architects. Illustrated). Am Arch–June 6. 1300 w.

6490. The Modernizing of Italian Cities. From the *N. Y. Times* (Improvements in the cities of Italy since 1870). Am Arch–June 6. 1300 w.

*6493. Fenestration (Treats of the importance of the design and arrangement of the windows of buildings). Arch, Lond–May 29. 2000 w.

Heating and Ventilation.

5948. Ventilation and Heating—Principles and Applications. A Treatise. B. F. Sturtevant Co., Boston, Mass. (A trade publication containing a valuable essay on heating and ventilating by forced ventilation, or by use of fan blowers for forcing air through pipes or ducts to all parts of buildings. Can be obtained free on application to B. F. Sturtevant Co., Boston, Mass). 169 pages.

6095. Hot-Water Heating and Ventilating of the U. S. Post-Office Building at Lowell, Mass. illustrated detailed description). Eng Rec–May 16. 1400 w.

*6156. Furnace Work (An argument favoring placing registers near inner walls). Dom Engng–May. 800 w.

6168. Heating the Law Courts Branch of Lloyds Bank, Limited, London, England (Illustrated description of building and plant). Heat & Ven–May 15. 1700 w.

6169. Dimensions of Registers and Ventilating Flues. R. C. Carpenter (From "Heating and Ventilating Buildings." Presented largely in tabular form). Heat & Ven–May 15. 1800 w.

6170. Economy of Heating with Exhaust Steam (Presented in form of questions and answers, with tables and formula for computing per cent. of gain or loss). Heat & Ven–May 15. 900 w.

6171. Mill Heating (Facts taken from paper of Geo. W. Weeks, which was read before the New England Cotton Manufacturers' Assn. Illustrated description of a novel arrangement). Heat & Ven–May 15. 2000 w.

6172. Ventilation of Buildings. R. C. Carpenter (Translation from Peclet's Traite de la Chaleur, with notes). Heat & Ven–May 15. Serial. 1st part. 3300 w.

6350. Improving Old Steam Plants (The possibility of large economy, by substituting up-to-date steam plants in old buildings, for those put in at an earlier date is demonstrated by an example and a statement is given of saving in fuel thereby). Mas St Fitter–May. 1300 w.

6469. Heating of the Lord's Court Building (Illustrated description of a system of heating by exhaust steam for a fifteen story building). Eng Rec–June 6. 1200 w.

Landscape Gardening.

6148. The Revised Plan for Jackson Park, Chicago (A reduced sketch of plan prepared by Messrs. Olmsted, Olmsted & Eliot; also plan for the World's Fair site, which covered the same area. The sketch is explained and the intended treatment described). Gar & For–May 20. 1500 w.

6396. County Parks (Editorial giving reasons why such parks are desirable, as set forth by Prof. T. H. Macbride in a bulletin from the Natural Hist. Laboratories of the State Univ. of Iowa). Gar & For–June 3. 1200 w.

*6404. The Palisades National Park. Waldo G. Morse, in *The Home Magazine*. An entertaining article advancing reasons why the government should own the Palisades and establish a military park). So Arch May. 2700 w.

Plumbing and Gas Fitting.

*6110. Drainage and Sanitary Equipment of the Hotel Cecil (A brief description of the sanitary arrangements in a hotel containing about 1000 rooms, and covering an area of 2¼ acres). Builder–May 9. 1800 w.

*6154. Plumbing Details in Three Large Apartment Buildings (Illustrated detailed description of plumbing above the average for this class of buildings). Dom Engng–May. 2800 w.

Miscellany.

*6155. Early Plumbing in the Metropolis of the Mississippi. T. D. Turner (Interesting reminiscences of western plumbing in the "forties"). Dom Engng–May. 1800 w.

CIVIL ENGINEERING

For additional Civil Engineering, see "Railroading" and "Municipal."

Foundations for Heavy Buildings.

MR. CHAS. SOOYSMITH'S paper before the American Society of Civil Engineers, reprinted by *The Engineering Record*, is an admirable review of the progress made in this department of engineering work. Nowhere, perhaps, have recent problems been more serious or more imperious in their demand for immediate solution. Mr. Sooysmith says:

"As the thoughtful engineer views the building methods prevailing to-day, it would seem to him that there is perhaps no kind of construction where the force of habit has so disastrously hampered a proper and quick readjustment to new conditions. Buildings of the heights usual until recently seldom put upon the earth supporting them weights greater than three or four tons per square foot, and generally much less than this. The weights were distributed and spread without difficulty by the common methods that had always been used. Of course there was occasionally some particular case sometimes treated in an exceptional manner, but these were never important or numerous enough to bring about any radical change, either in the general carelessness with which the matter of foundations of buildings was considered—or rather not considered—or in the method of constructing them. With the sudden doubling of the usual height of buildings, and the consequent great increase of weight, the old foundation methods became, in many cases, entirely inadequate. If pursued, serious settlement was invited from overloading, and the danger of letting down the underlying material by lateral flow became considerable. In fact, the problem of foundations for a heavy building, where they are not carried to rock or hardpan, has now become (and this fact seems to be strangely overlooked) one very largely of what vent may be given for the underlying material by excavations in the vicinity. It is not sufficient that the weight put upon the soil should not be so great as to cause serious settlement. Under the conditions existing this is not generally difficult, but the material must not be put under a pressure that will cause it to squeeze out from below, in case an opportunity is afforded by deep excavations near by. It will become apparent, ere long, that the erection of heavy buildings resting upon sand or soil which they unduly overload, without carrying their foundations on piles or to solid material, has in many cases worked a serious wrong to owners of the adjoining lots, besides being itself a short-sighted economy, because of trouble and lessened value of the buildings so built.

"Where soils are overloaded, there is extraordinary potency in slight vibration to cause settlement where the conditions are favorable. Hoisting engines are frequently found to be exciting causes in producing unequal settlement in the absence of unequal loading. In one case in lower New York, where a very massive and well-built structure resting upon gravel and sand cracked after it had been in use a considerable time, the only new condition introduced to which it seemed possible to attribute the settlement manifested was pumping clear water from a near-by driven well. It seemed reasonable to assume that the water flowing through the sand made possible a slight readjustment of the particles, which settled into closer union under the vibration of the machinery in the building.

"A most interesting thing often shown by the settlement of buildings is the frequency of movement of the entire mass of soft material in the vicinity of rivers. There is a locality in New York city where there is good reason to believe such a motion to be taking place. For instance, a certain large and well-constructed building resting upon a well-designed pile foundation, and where the piles were driven 40 or 50 feet into the silt, started to settle probably before it was completed; at any

rate, it settled from almost nothing at the end farthest from the river to some two feet at the end nearest the river, making a practical wreck of part of the structure. This building was some 200 or 300 feet from the river. An examination of the bulkhead wall showed that the piers had apparently acted as buttresses to hold it back, but that between the piers it was bowed outward. This, in connection with other evidence, seemed to point indisputably to a movement of the entire mass of the adjacent material toward the river."

"The first method that naturally comes to mind for providing a better foundation than can be done by simply spreading the bearings on the earth at customary depths is that of driving piles, and, where there is reasonable certainty that these will always remain wholly submerged, this is generally the best possible foundation, considering its cost, for buildings of considerable, but not of the greatest, weight. The New York building law permits a load of twenty tons per pile, and engineers will consider this, when fair-sized piles are used, to be within good practice; but there are many cases where it is certainly a great mistake to take the aggregate bearing capacity of a pile foundation to be the sum of the safe loads on the individual piles composing it. . . . If the stratum below the piles be at all yielding, it is probably true that the bearing capacity of the foundation is the bearing capacity of the stratum below the piles plus the friction of what might be considered the outer side surface of the entire mass penetrated by the piles."

"A practical difficulty which is apt to hamper the building of a good pile foundation for a building very seriously where there are a great number of piles close together is that, after driving the first few, the material near them becomes so compact that it is exceedingly difficult, and sometimes impracticable, to get the remaining piles down to anything like the contemplated depth. . . . This difficulty is readily overcome where the use of the jet may be resorted to. This is often dangerous in proximity to other buildings, and, it sometimes seriously cracks the adjoining building to drive piles close to it."

"In considering the provision for an adequate foundation for a building, the weight of which seems to demand something better than the old style of simple foundations, the first natural thought is to increase in some way the spread of the foundation so that the unit weight on the material may be kept within allowable limits."

"This has resulted in the so-called raft system of foundations, in which, by alternate layers of steel beams of lessening length, it is practicable to spread the bearing to a sufficient extent. This method requires the minimum depth of excavation, and gives the minimum amount of cellar space. Short of some method of carrying the bearings to a lower and more substantial stratum, as by piles or by excavation to bedrock, this would seem to be the best possible treatment of the problem under such conditions as exist at Chicago.

"In considering the loads to be provided for by the foundations for the Manhattan Life Building, it was found that, if piles were driven over the entire space to be covered by the building, enough piles could not be driven on the lot to sustain the building and load the piles within the limit permitted by the building law. Thus, unless the simple method of spreading the foundations were considered satisfactory, which in this case was out of the question, there was no way but to carry the column loads from the bedrock, which in this case was fifty-four feet below the Broadway street level. The borings taken on the lot indicated the existence of more or less quicksand, and it was feared that any effort to excavate for foundations in the open to the bedrock would result in an inflow of material that would endanger the adjoining buildings. For this and other reasons, the architects, Messrs. Kimball & Thompson, decided upon the use of steel caissons sunk by the pneumatic process, and thus came about the first use of this method.

"Its advantages are: first, the excavation can be carried on under pressure, which holds back from inflow any outside material; second, any obstructions met with in the sinking can be removed with-

out serious difficulty or delay; third, the bottom can be examined, and, where necessary, leveled or stepped; fourth, the work can be executed with speed, because the caissons can be brought on the lot, finished or ready to put together, and, while these are being sunk, the brickwork to form the permanent pier can be built upon them, so that, when the excavation for each foundation is completed, the pier itself is finished.

"The foundations for the new Johnston Building have been successfully put in by means of open wrought-iron cylinders sunk by the water-jet process. This method, while somewhat cheaper than the pneumatic, would seem to be open to the objection that it might not permit in some cases a proper examination and preparation of the bottom and of building the foundation in the dry, and, too, should flowing material under heavy pressure from beneath an adjacent building be encountered, a possibly dangerous vent might be afforded. As yet the pneumatic process is the one safe and sure method for deep excavations, by which all dangers of quicksand or other difficulties can, with certainty, be quickly overcome and a perfect foundation constructed, and this too at a cost, where the conditions are determined, which can generally be estimated with comparative certainty."

The Supporting Power of Piles.

THE RAILWAY REVIEW copies a paper by Franz Krenter, professor of civil engineering in the Royal Technical High School of Munich, read before the Institution of Civil Engineers and devoted to the exposition of a new method for determining the supporting power of piles.

Mr. Krenter calls attention to the frequent impossibility of making this determination by the direct application of a sufficient load, and the resultant practice of attempting to deduce the desired result by the use of rational or empirical formulæ, all of which he considers defective, on account chiefly of the following uncertainties.

"(1) The blow or concussion between the hammer and the pile is usually, for safety, supposed to be inelastic; but this is obviously not the case. The allowance, however, which should be made for the elasticity of the blow is unknown.

"(2) It is not certain whether, as being compressed by the action of the blow, a length equal to the whole actual length of the pile or to some part of it only should be introduced. Redtenbacher in his formula inserts the whole, Rankine only one-half, of the real length of pile.

"(3) The weight of the timber of which the pile consists, and which is introduced into Redtenbacher's formula, varies for pine between 30 pounds and 44 pounds per cubic foot.

"(4) The modulus of elasticity of pine may vary between 1,400,000 pounds and 1,800,000 pounds per square inch.

"These formulas in consequence differ widely in their results. Other formulas in which the compressibility of the timber is neglected are to be condemned as being apt to lead to serious errors in all cases, unless the influence of the elasticity of the timber is inappreciable. This only occurs when a comparatively light pile is driven into soft ground by heavy blows. The empirical formulas are in most cases merely based upon conjecture rather than upon reliable observation, for the reason that the real supporting power of bearing-piles cannot always be tested by the application of a sufficiently large dead load. On the most favorable assumption they will be approximately correct only for cases similar to the one from which they have been deduced, and their generalization will always be open to suspicion. They are, therefore, still less trustworthy than rational formulas.

"The author proposes to show a new method, at once simple and reliable. The supporting power is generally required only when the pile has been already driven into the ground to a considerable depth, and sinks comparatively very little further after a certain number of subsequent blows or sets of blows. It may in that case be concluded that, when the penetration of the pile after a blow has become very small in comparison to the total depth already attained, the increase of

supporting power will be also small in comparison with the total supporting power it already possesses.

"Now, let W be the weight of the hammer and h the height from which it falls, then gives—

$$E = W h \quad \ldots\ldots\ldots\ldots \quad (1)$$

the energy of the blow or set of blows, as the case may be. This energy is spent in producing a number of different effect, which, however, may be summed up in two classes, one of which represents the useful work, whilst the other comprises all that work which is of no use for the particular purpose, and which may therefore be regarded as lost. Let the former be expressed by U and the latter by V; then it is evident that—

$$E = U + V.$$

U only represents the work done in driving the pile against the resistance of the ground through a measurable distance or depth d; and this resistance of the ground to the penetration of the pile is the bearing power of the latter, L; therefore

$$E = Ld + V \quad \ldots\ldots\ldots\ldots \quad (2)$$

The hammer only does useful work from the moment when the pile begins to move or as soon as

$$d > 0.$$

As long as d remains zero, all the work done by the hammer is useless or lost. Let E_o be the energy necessary to balance the loss V at the limit when the pile will just begin to penetrate further; then

$$V = E_o$$

If now the value E_o be found beyond which the loss V cannot increase—because for any value of $E > E_o$ the resistance of the ground is overcome and the pile will penetrate, it follows directly from (2) that

$$L = \frac{E - E_o}{d} \quad \ldots\ldots\ldots\ldots \quad (3)$$

It is true that E_o cannot be determined in a direct manner; but it may be deduced with sufficient accuracy from the result of two subsequent blows or sets of blows in the following manner: Make two consecutive and efficient sets of an equal number of blows, but of different energies, E_1 E_2; that is to say, in using the same hammer apply different heights, h_1, h_2. If the pile still advances considerably, let the blows of the second set be the weaker; if the advance of the pile is small, let the second set of blows be the heavier. Let d_1, d_2 be the depths through which the pile is driven by the action of the energies E_1, E_2, respectively; then, subject to the condition that d_1 as well as d_2 be sufficiently small in comparison with the whole depth already attained, it may be assumed that L as well as V will remain sensibly constant in passing from the first set of blows to the second, so that from (2) it may be deduced

$$\frac{d\,(E)}{d\,(d)} = \text{constant, nearly.}$$

The law according to which E and d vary together may, therefore, in this case, and within the limits in question, be approximately represented by a straight line, inclined toward the rectangular axes of coordinates and intersecting one of them in the point corresponding to

$$d = 0,\ E = E_o;$$

so that

$$\frac{E_1 - E_o}{E_2 - E_o} = \frac{d_1}{d_2},$$

whence

$$E_o = \frac{E_2 d_1 - E_1 d_2}{d_1 - d_2} \text{ nearly} \ldots. \quad (4)$$

"If now in (3) and (4) the number of blows used in the testing set be cancelled, the equations may take the form

$$L = \frac{h - h_o}{D} . W \ldots\ldots \quad (3a)$$

$$h_o = \frac{h_2 D_1 - h_1 D_2}{D_1 - D_2} \ldots\ldots \quad (4a)$$

where D is the average depth through which the pile is driven by one blow of the respective set of blows.

"Since, for h and D in (3a), h or h_2, and D_1 or D_2 respectively, may be substituted, the bearing power of the pile may be finally expressed

$$L = \frac{h_1 - h_2}{D_1 - D_2} . W \ldots\ldots \quad (5)$$

"This method is more reliable than any other, dispensing as it does with all uncertain assumption, and being merely founded upon observations in connection with the special case in question.

"Preparatory to ascertaining the supporting power of piles by the method explained, the following precautions are of great importance:

"(1) The piles should rest for some time, in order to allow the stresses produced in the ground by the penetration of the piles to be relieved. It has been stated from experience that piles frequently penetrate with renewed ease after some days' rest. An immediate test-driving might, therefore, lead to erroneous results, and too high an estimate of the supporting power of the piles.

"(2) The heads of the test piles should be sawn off to present a sound and solid surface to the blows of the hammer.

"(3) The number and force of the testing set of blows should be such as not to crush the head of the pile."

The Biscay and Mediterranean Canal.

A RECENT editorial in *The Engineer* (London) says:

"The project of uniting the Bay of Biscay with the Mediterranean by means of a canal capable of accommodating large seagoing vessels has again met with condemnation at the hands of the commission appointed by the French government to investigate the matter. For many years the idea has attracted a good deal of attention, not only from the commercial advantages which would arise from a shortened length of voyage between the ports of northern Europe and the Mediterranean, but also to a large extent from the desire to provide a means of naval communication for the French fleet in time of war, without being compelled to pass under the guns of Gibraltar. In *The Engineer* of November 9, 1894, we gave some particulars of the various schemes which had been proposed for the construction of such a canal, and then expressed the opinion that it seemed to be a waste of time and money to make further investigation into their feasibility. The engineering features present no special difficulty; there is no doubt about the possibility of making such a canal, but it would be at such a cost as to make the investment distinctly unprofitable. The promoters of the present scheme have had the benefit of the fullest publicity and criticism. Premiums amounting to £4,000 were offered for competitive designs, and an exhibition of the various plans was held in Paris in June, 1894. Various ideas of a more or less original nature, including ship railways and rolling docks propelled by electricity, had their respective advocates. The several schemes finally selected indicated a canal of a length varying from 220 to 320 miles, of a size sufficiently large to admit of navigation by the largest armor-plated war ships, and at a cost estimated at £40,000,000 to £60,000,000. After repeated pressure the French government, towards the end of last year, consented to appoint a commission of engineering and commercial experts to inquire into the practicability of the idea, and their report has just been issued. From the financial point of view the commissioners cannot see that there is any probability of a large enough traffic being attracted to the new canal to make it a profitable investment. Then the shortening of the distance between the ports of northern Europe and the Mediterranean would be largely discounted by the slow speed necessitated in navigating a canal where the waterway would be restricted and the locks numerous, so much so that little time would be gained by the new route. Objection is also raised to the danger of floods along certain sections of the canal which it was proposed to construct in raised embankments. The commissioners unanimously condemn the project as one which it is inadvisable to attempt to carry out. After the thorough investigation which the various schemes of the last twenty years have received, it is probable that this is the last that will be heard of the idea for some time to come."

It would be, perhaps, quite natural that a distinctively British journal should not be favorably predisposed toward a scheme which would "provide a means of naval communication for the French fleet in time of war, without being compelled to pass under the guns of Gibraltar," but there need be no suspicion that the condemnatory judgment expressed by *The Engineer*

has any national bias. The era when works of this character are constructed for purely military reasons is, happily, passing, and the great thoroughfares and lines of traffic are becoming more and more the instruments of peace than of war.

It is doubtful if any project of this nature and extent could command national support at the present day, unless its economic value were made apparent; in this case the advantages to be gained from the use of the canal seem so small that it appears highly improbable that enough tonnage would seek it to begin to pay any adequate interest on the outlay.

Such schemes, however, have a way of reappearing at periodic intervals, to be re-examined and decided anew in the light of the latest methods and conditions.

Engineering science is rapidly advancing, and the conclusions of the "last twenty years" often have to be considerably modified.

Cost of Excavation on Ship Canals.

IN a communication to *Engineering* (London), Mr. Henry E. P. Cottrell gives some interesting details in the construction of ship canals, which he has condensed into the following table.

TABLE SHOWING THE ACTUAL COST OF EXCAVATION ON SHIP CANALS AND THE PROPORTION IT BEARS TO THAT OF ACCESSORY AND CONTINGENT WORKS.

Name of Canal.	Cost of Excavation per Cubic Yard	Cost of Excavation per Mile of Canal.	Cost of Excavation per Cent. of Total Cost	Nature of Excavation.
	d.	£		
1. Suez Canal	19.30	84,437	37.47	7.2 per cent. of rock.
2. North-East Sea Canal	8.12	57,517	45 11	
3. Manchester Canal	17.66	103,782	30 98	22 per cent. rock, some blasted and dredged.
4. Corinth Canal	20.35	344,254	42.39	10 per cent. rock.

Remarks.— 1. Incidental and extraordinary expenditure was involved through the enforced substitution of costly mechanical appliances and high-priced labor for cheap "fellah" labor when the work was far advanced, and by financial difficulties incident on political complications. The accessory works comprised the forming of a large harbor with two breakwaters at Port Said, and an embankment and breakwater at Suez, the cutting of two canals for the supply of fresh water 97 miles in length, and the laying of duplicate water mains 50 miles in length, etc.

2. Incidental and extraordinary expenditure was involved only in connection with the bogs and quicksands cut through by the canal and a few slips, this being one of the few first-class public works which seems to have been thoroughly thought out and planned in all details previous to commencing the works, and carried out in strict accordance therewith. The accessory works comprised terminal and intermediate locks and sluices, two high-level and long-span railway bridges, the Elder and Büttler Canal works, ferries for intersecting roads, fortifications, land expropriation, etc.

3. Incidental and extraordinary expenditure was involved in the special difficulties occurring in converting a large river subject to high floods into a deep canal for shipping, and continuing this alongside a tidal estuary, and in the alterations consequent on the substitution, when the works were far advanced, of company construction for construction under contract. The accessory works comprised the Manchester Docks, over 100 acres, 15 miles of deviation of railways, with four very high viaducts having openings of large spans, 7 miles of mains for hydraulic installation, numerous locks, great sluices and swing bridges, and last, though not least, costly expropriations of land and houses and parliamentary expenses.

4. Incidental and extraordinary expenditure was involved in the change of methods in carrying out the work during construction, in stoppage of works for several months, and in the financial difficulties encountered during their prosecution. The accessory works comprised the formation of two terminal harbors, with three breakwaters, the building of two masonry retaining walls along the entire length of the canal from the bottom of the slopes to above water level, and the lining and facing with masonry of weak points in the lofty slopes to protect them from weathering and breaking away; also the diverting of the railway and carrying it across the canal on a high-level long-span bridge.

Proposed Engineering Experiment Stations.

THE Engineers' Club of St. Louis, at their meeting June 3d, received the report from the committee to whom had been submitted for recommendation the bill proposing to make an appropriation for the establishment throughout the United States of "Engineering Experiment Stations."

The conception was no doubt supposed to be similar to that which organized the existing agricultural experiment stations; but the project in this case does not design to wait the slow process of organic growth, but rather to spring suddenly into existence, fully matured and equipped. $10,000 a year is to be immediately set aside for each state and territory, and the sum

is to be increased by $1000 annually for the next fifteen years until each state and territory receives $25,000 per annum "for the purpose of providing for engineering experiments" in about fifty different laboratories, "most of which" the committee finds "are now and would remain in relatively incompetent hands."

It is hard to believe that so unnecessary and ill-advised a measure could ever get beyond the lobby. Any supposed analogy to the Agricultural Experiment Stations, is mistakenly conceived. These latter find an excuse for their multiplication in the widely differing conditions of topography, meteorology, soil and climate which make equally varied crop possibilities in closely adjoining sections, and present problems of selection, rotation and culture constantly changing in all the essential factors. Opinions will differ as to the wisdom of the general government taking even such participation as this in economic affairs, but there is at least the excuse of contributing to the enlargement of the total national wealth and production.

Engineering experiment is of a totally different character; the science is exact and the experiments are generally wholly independent of the location of the laboratory itself.

A moderate expenditure in one good laboratory might be a proper and valuable aid for the Government to afford to engineering research, but a very small increase of the amount now appropriated for the Watertown Arsenal would do more good than the $1,250,000 which this proposal would fritter away in fifty duplicate and unnecessary plants.

The entire value of the establishment would seem to be to politicians seeking enlarged "patronage," and it is gratifying to know that the St. Louis Engineers' Club withheld any recommendation of the measure.

THE ENGINEERING INDEX—1896.

Current Leading Articles on Civil Engineering in the American, English and British Colonial Engineering Journals—See Introductory.

Bridges.

*5974. Opening Bridges. George Wilson (A classification after Rankine of the different ways in which a movable bridge is capable of motion, and a historical account of drawbridges are given in the first part. Also a table of the drawbridges in the United Kingdom, with dates of their erection, rivers, etc., crossed, dimensions, how carried, and methods of moving them is appended). Prac Eng–May 1. 2200 w.

5999. Raising a Highway Bridge (Description of the raising of a viaduct bridge whose pedestals had settled, and query as to the action under load of a clay stratum, overlying soft soils). Ry Rev–May 9. 900 w.

†6081. Strength of Concrete and Steel in Combination. Frank H. Constant (A discussion of this combination which has become quite common in laying the foundations for tall buildings, floors of bridges and buildings, arch bridge constructions of the Monier and Melan systems, etc). Engineers' Year Book-Univ of Minn. 2000 w.

6200. The Bridge Problems of the Greater New York (Editorial presenting the advisability of bridge construction between New York and Brooklyn in order to hasten, with facilities for communication, the real union which is to take effect Jan. 1, 1898). Eng Rec–May 23. 900 w.

6202. Widening a Swiss Arch Bridge (Sidewalks of 5¼ ft. are increased to 10½ ft. each, by the addition of a pair of iron corbels or brackets at the top of each pier, which support at their outer ends a longitudinal girder upon which the outer ends of the sidewalk transverse joist are carried. Illustration of structure, elevation, etc). Eng Rec–May 23. 150 w.

*6241. New Cantilever Bridge at Paris (Description of the Pont de Mirabeau, which was opened for traffic on April 20, 1896. It is composed of a river span of 100 m. and two half-spans of 36 m. each). Eng, Lond–May 15. 900 w.

*6254. Some Curious Bridges (An interesting article describing some mediæval bridges of note and of historical interest). Ill Car & Build–May 15. 2800 w.

*6327. Timber Bridge Construction in New South Wales. Percy Allan (Read before the Engng. Soc. of the Royal Soc. of N. S. W. Illustrated description of improved construction). Eng, Lond–May 22. 4500 w.

*6459. Swing Bridges in the Port of Marseilles (A summary of an essay of an Italian government engineer, E. C. Cagli, which is a valuable investigation on the more important of the numerous swing bridges that have been constructed in the port of Marseilles for the accommodation of the road and railway traffic in and about the docks of that city). Engng–May 29. 1200 w.

Canals, Rivers and Harbors.

*5939. The Absence of Facts About the Nicaragua Canal. Charles B. Going (Showing the insufficient investigation and erroneous claims upon the strength of which the United States is asked to risk at least a hundred millions, and

nobody knows how much more). Eng Mag–June. 4300 w.

*5944. Bank Revetment on the Mississippi River, Ill. H. St. L. Coppée (A description of the methods adopted for the protection of the Mississippi's banks with a view to continuous deep-water navigation). Eng Mag–June. 4000 w.

*5971. The Nicaragua Canal Estimates (Editorial. Surprise is expressed that a difference of 13 millions sterling more than the estimate of Nicaragua Canal Co. should have been presented in the estimate of the United States government commission, and the editorial is substantially a review of the report of the commission). Engng–May 1. 3000 w.

*6104. The Thames and Severn Canal (Historical description with map of route, connections and illustrations). Eng, Lond–May 8. 1700 w.

6178. The Jetties at Galveston Harbor. Walfred Wilson (Illustrated description). Sci Am–May 23. 1000 w.

*6237. The Manchester Ship Canal, and Canal and River Hydraulics (A discussion of the "omnibus bill" promoted by the Manchester Ship Canal Co.—What ground it covers and the opposition, with reasons). Eng, Lond–May 15. 2800 w.

*6243. The Crinan Ship Canal (A short account of the present canal, with details of a proposed canal along the same route, capable of accommodating vessels drawing 18 ft. of water. Map). Eng, Lond–May 15. 1000 w.

6292.—$1.50. Improving the Entrance to a Bar Harbor by a Single Jetty. T. W. Simons (The writer, convinced that there are places where a single jetty will, if properly placed, accomplish all that could be expected of two jetties, decided that Gray's Harbor in the State of Washington was such a place. The improvement of the harbor was so planned, and a description is presented with facts and reason which led to the adoption). Am Soc of Civ Engs–May. 4800 w.

†6470. Mechanical Methods of Rock Excavation Used on the Chicago Main Drainage Channel. Ill. W. G. Potter (Treating first of the methods of excavation in a few of the recent foreign canals, and of the rock excavation on the Chicago Main Drainage Channel, with particular reference to cost of work. Also abstracts of papers in foreign and American transactions and periodicals, on the status, cost and progress of work on this canal). Jour of W Soc of Engs–April. 14500 w.

Hydraulics.

*6103. Reservoir Dams with Iron Sheeting. Thomas Thomson (An investigation of the points in favor of a dam constructed in this manner. The only disadvantage is fear of corrosion, but with proper precautions the writer thinks it can be so constructed as to last centuries. The cost is only about one-third of that for masonry dam construction). Eng, Lond–May 8. 1800 w.

6288.—$1.50. Flow of Water in Wrought and Cast-Iron Pipes from 28 to 42 ins in Diameter. Isaac W. Smith (Description of the water supply of the city of Portland, Ore., with tests carefully made, and tables). Am Soc of Civ Engs–May. 4600 w.

†6471. Co-efficients in Hydraulic Formulæ, as Determined by Flow Measurements in the Diversion Channel of the Desplaines River for the Sanitary District of Chicago. W. T. Keating, with Discussion (Measurements made according to instructions of T. T. Johnston). Jour of W Soc of Engs–April. 3800 w.

Irrigation.

†6076. Irrigation Engineering in the United States. C. H. Kendall (The importance of the question is shown, and in a general way the paper discusses the present practice and methods employed in the west). Engineers' Year Book–Univ of Minn. 2500 w.

*6235. Our Sub-Arid Belt. E. V. Smalley (An examination of that portion of the prairie land where climate and soil appear inviting to agriculture, but where there is not sufficient rain fall for profitable tillage. The conditions that have proved discouraging are presented, and irrigation by artesian wells, and what it has accomplished is explained. A theory of special methods of soil-culture is being put to practical tests. The writer advocates the scientific study of this region at government expense). Forum–June. 3800 w.

6001. New Method for Determining the Supporting Power of Piles. Franz Kreuter (Read before the foreign Inst. of Civ. Engs. The method is described as consisting in making two consecutive sets of blows with differing energy; and the formulæ deduced from the data are said to be much superior to those generally in use). Ry Rev–May 9. 1000 w.

6022. Effects of Engineering Works on Water Currents. Cyrus Carroll (A study of the effects of piers, wharves, abutments, breakwaters, etc., on the currents, and the damage done by too little attention being given to this subject). Can Eng–May. 2200 w.

†6083. Latitude. William R. Hoag (An article showing how a civil engineer, with his ordinary transit, can easily establish his latitude within 10 seconds and with the aid of a sextant he can determine it within 3 to 5 seconds). Engineers' Year Book–Univ of Minn. 2000 w.

6201. The Simplon Tunnel (A brief account of this tunnel through the Alps, 12½ miles long, to be constructed at a cost of $13,500,000). Eng Rec–May 23 1300 w.

*6246. Tunnelling by Compressed Air. E. W. Moir (Read before the Soc. of Arts. Illustrated review of "shield-driven" tunnels, dating from the time of Brunel. The description of the work done by compressed air is very interesting). Jour of Soc of Arts–May 15. 10500 w.

*6475. Notes on Cement Mortars. Edward Mead (Practical experiences in inspecting and testing cements, and facts which may serve as means of determining reliable materials for cement mortars, thus rendering a more satisfactory grade of work. A large number of tests of cements manufactured in the Louisville district, are given with results). Eng Assn of the South–April. 4800 w.

ELECTRICITY

Articles relating to special applications of electricity are occasionally indexed under head of Mechanical Engineering, Mining and Metallurgy, Railroading, and Domestic Engineering.

Electrical Energy by Direct Conversion.

A LABYRINTH having an infinite number of sealed chambers, each one opening into others, and each containing treasures and hidden keys which unlock hitherto-closed doors of unexplored regions,—such is nature. Every newly-opened door is an assurance that there are other doors to unlock, and that the means of ingress to that which is hidden beyond exists. We shall enter, if we persevere; but the end of the labyrinth will never be reached. The discovery of a Crookes opens the way for a Röntgen, a Tesla, an Edison, a Moore. Chemical discoveries of remote date have given to Dr. William W. Jacques of Newton, Mass., the key to the long-anticipated and much desired solution of the problem of direct generation of electrical energy from carbon.

An account of this discovery is found in an able leading article, by Mr. George Herbert Stockbridge, in the present number of this magazine. Another account is presented in *Western Electrician* (May 23). As this discovery is of a revolutionary character, it is destined to rival Röntgen's discovery in scientific and practical interest.

Although yet in its early infancy, one can foresee far-reaching effects, of which probably those now living will see the accomplishment. Many scientists and engineers have indulged in speculation upon the results that must follow the production of electricity by a much cheaper method than was known prior to Dr. Jacques's discovery. The chemical and mechanical methods hitherto used have been expensive and wasteful; yet, in spite of these drawbacks, the ever-increasing number of the applications of electricity to the wants of mankind is the greatest marvel of our age. If, however, as alleged, it may be reasonably expected that the yield of electricity will be increased by Dr. Jacques's discovery ten-fold, as compared with coal-consumption in the production of electricity by the use of steam boilers, engines, and dynamos,—all of which will be supplanted by the simple apparatus Dr. Jacques employs,—the most unrestrained flight of fancy can hardly cover the extent of the industrial and social revolution that has even now begun.

What room will there be for the steam engine, when the energy for direct driving of electric motors can be obtained at the rate above indicated? And what will become of the legion of gas-motors and oil engines? How will ships be propelled, and passenger trains be drawn across the continents? And what limit can the imagination set to the multiplied field for electro-motors in the shop, the household, the factory, the dairy-house, the forest, and the cultivated field? Verily, if all that is stated about this discovery be true (and all indications point to its truth), we have, at last, directly tapped the great universal reservoir of energy, and may henceforth command a wealth of mechanical power beyond conception.

But, when we have this plenitude of resource, and the need for physical labor has been again reduced to a point far below the present limit of such need, the adjustment of social relations—already a most difficult problem—will press harder than ever upon economists, statesmen, and philanthropists. In view of all these possibilities, now so imminent that they may reasonably be called probabilities, the mind staggers in the attempt at a conception of all the industrial and social changes which will mark the progress of the twentieth

century. For, even were we to doubt that the discovery of Dr. Jacques can be made commercially practicable, all signs point to the practicable solution of this problem in some way before long, and wonderful discoveries and advances now follow each other in so rapid succession that scientific men and the engineering world are everywhere holding the attitude of expectancy. So overmastering is the feeling that we are on the eve of great discoveries that many hesitate in developing inventions, through the fear that, in this rapid march, anything they devise will soon be left far behind the procession. Nor is this fear without warrant. The present generation has seen the rise of electric-arc and incandescent lighting, and it is not unlikely that the same generation will see the abandonment of the practical use of these systems in general illumination. The advances made in vacuum-tube lighting by Moore, Tesla, and Edison are portents of the end of existing methods, and promises of a new order of things which not only will include an improved mode of illumination, but will supply the key to other hidden treasures, perhaps never yet dreamed of. Time will show what is yet to be; but, when we reflect on what has been in the short interval of thirty years, and also consider that what has been done supplies the means for yet more rapid advance, we are justified in deeming almost anything within the limits of natural law as not only possible, but probable.

Dynamos for Telegraph Working.

THE names of W. Slingo and A. Brooker are well and widely known as the authors of a valuable treatise entitled "Electrical Engineering." Anything these authors write will be regarded by electrical engineers as worthy of careful consideration. In *The Electrical Review* (London, May 1) they speak of advantages that are possible in many cases through the substitution of dynamos for batteries in telegraph working. An abstract of their joint paper follows:

Except in a comparatively few instances, primary batteries are still employed for working telegraph lines, and, generally, every line or circuit has its separate battery. So far as freedom from break-down or interruption due to a failure of the source of power is concerned, this is, without doubt, the ideal system. The space occupied and the amount of wiring involved are, however, considerable, as may be gathered from the fact that, on a single line worked on the Delany multiplex system, no less than ten separate batteries at each end of the line would be required, having an electromotive force ranging from about eight to, in some cases, two hundred and forty volts. These high pressures are never allowed to get onto the line, for, taking into account the resistance, apparent and real, of the apparatus, etc., the maximum potential difference between the nearest insulator and earth is in no case allowed to exceed one hundred and twenty volts.

It is evident, however, that, when primary batteries are employed, the number of cells required for a large station amounts to many thousands, and the prime cost, cost of maintenance, and space occupied are very great, because the batteries must be arranged so that every cell shall be easily accessible for inspection and renewal, and a considerable number of spare batteries must be kept ready for emergencies, and to replace defective ones while the latter are being examined and brought into good order.

Given two batteries of different types of cell, but of equal internal resistance, electromotive force, and constancy, there is absolutely no difference in the speed or efficiency with which a line can be worked from these batteries, although the contrary opinion frequently obtains. There is one practical objection to the use of a battery of very low internal resistance,—*viz.*, that a heavy current results when the battery is short-circuited, accidentally or otherwise; and the apparatus and battery are then liable to injury. Further, some classes of reversing apparatus have to be so adjusted that the battery is momentarily short-circuited every time the current is reversed, and consequently the battery resistance must in such cases be sufficient to avoid the risk of a too heavy current passing through the apparatus; it should certainly

be not less than two ohms per volt. In the event of a very low resistance cell being employed, the resistance may be brought up to this amount by the insertion of an artificial resistance.

The best way of reducing the space occupied by the batteries is to employ a "universal" system of working,—that is, to supply a large number of circuits from one battery. The problem is a very simple one, when the lines offer approximately the same resistance and are worked by single current, as it is necessary only to permanently earth one pole of the battery, and from the other pole run a lead to the key or sending apparatus of each circuit (see Fig. 1). It is necessary to ensure that any one line shall get approximately the same current, no matter whether all or none of the other lines are working,—that is, the point, C, from which

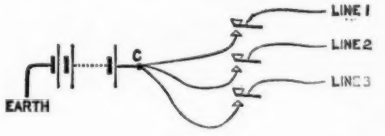


FIG. 1.

the battery leads radiate, must, under all circumstances, be maintained at the same potential. The problem is precisely similar to that met in running a varying number of incandescent lamps in parallel without any perceptible variation in the luminosity of any one lamp; and it will be seen that it is necessary only to make the resistance between the point, C, and the earth, through the battery, *very* low; the arrangement would be perfect,—that is, there would be no variation,—if this part of the circuit could be made so as to offer no resistance at all.

It is, however, an expensive matter to construct and maintain batteries of such dimensions that a number of cells in series shall offer a resistance of less than one ohm. It can be done with secondary batteries, and practically without limit as regards the number of lines operated, but there are objections to this mode of working. Secondary batteries are expensive and require much attention, and a large proportion of the energy spent in charging them is wasted.

A recent installment of dynamos in the Chicago office of the Western Union Telegraph Company replaces no less than sixty thousand primary cells. The most interesting part of the installation is the arrangement of fifteen machines to supply current to the longer and more important lines. These machines are joined in three sets of five each, with their armatures in series, one set being always kept in reserve. The two working sets are used to supply positive and negative currents respectively, the negative terminal of one set and the positive terminal of the other being permanently earthed. These machines develop a potential difference (starting from the earthed end of the set) of 75, 75, 70, 70, and 60 volts respectively, and, consequently, the series may be tapped, either for single or double current working, at five points, the potential of these points being 75, 150, 220, and 350 volts.

In Fig. 2 is shown the various points of different potential connected to the

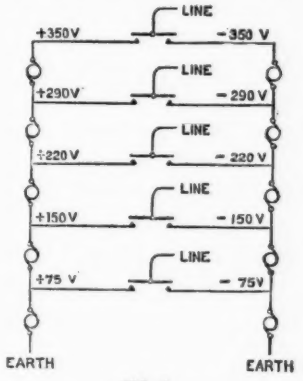


FIG. 2.

positive or negative studs of double-current keys or pole changers, and, of course, any number of connections may be so made, or either of the machines may be tapped at any point for single-current working. It will be observed that in the apparatus used on the longest lines a potential difference of seven hundred volts can be obtained. So high pressures are not employed in England for telegraph

work, but we presume that in the Chicago installation each circuit is well protected by fuses and resistance coils, in which case little inconvenience need be experienced, as the reversing keys or pole changers used in the States are actuated by a local circuit, and need not be touched by the operator except for the purpose of adjustment, in which case, we imagine, the battery leads would be temporarily switched off.

In order to facilitate the regulation of the pressure, only one machine in each set is self-exciting; and this supplies current to the other machines in the same set, all the field-magnet coils being arranged in parallel and provided with adjustable resistance coils.

Generally, the installation appears to have been carefully thought out, and, if it does not attain success, it certainly deserves it.

Messrs. Slingo and Brooker point out that an objection to such an installation is the necessity for continually running the whole plant even during those hours when the work is very light; and, with so large a number of machines, not only is the efficiency exceedingly low, but the risk of failure at some point or other must at all times be considerable.

The authors are of the opinion that a much more reliable and flexible system could be obtained by means of motor-generators run from lighting or power mains, which are always available at a large telegraph station, as the risk of failure of supply from such mains is, or should be, exceedingly remote. Such a system would be more efficient, and far cheaper to install and maintain, than either secondary batteries or dynamos used direct; the space occupied would be far less, and motor-generators could be used in much smaller stations than those in which it would pay to install dynamos and engines. A motor-generator, when intelligently used, requires exceedingly little attention, and is more reliable than any engine and dynamo combination; and changes can be effected as easily as with a set of batteries. We look forward with some interest to a trial of these machines for telegraph work.

Artificial Illumination.

IN a paper read before the Minnesota chapter of the American Institute of Architects, and printed in *The Improvement Bulletin* (April 17),—the following being an abstract of the paper,—Mr. George D. Shepardson makes some good points. The paper deals chiefly with the advantages of electric lighting as compared with gas lighting, but some principles often ignored by architects in their arrangement of electric lights in buildings merit careful consideration. A distinction is made between the appearance of illumination and actual illumination.

Illumination appearance is obtained by making the sources of light conspicuous. Familiar examples in Minneapolis are the circles of light about the towers of the Glass Block and Olson's, the incandescent crosses on the tower of the Wesley Methodist church, the rows of incandescent lamps along the cornice of the Plymouth, the illuminated signs across Hennepin and Nicollet avenues, the mammoth Ceresota sign above one of the mills, and Olson's illuminated street car.

Illumination without illumination appearance is found in the daylight, where the source of light is rarely looked at directly. Diffused daylight is the ideal toward which artificial illumination should strive. To secure perfect illumination, the source of light should be entirely outside of the range of vision, so that only such light may reach the eye as comes from the illuminated surface or objects. The angle of vision extends from fifty to ninety-five degrees each side of the center line of vision, being measured from the eye as the apex. The source of light should be well outside of this angle, since the eye adapts itself to the strongest light within the field of view. If the source of light is visible, the iris or curtain of the eye closes partially, and so reduces the amount of light reaching the eye from all sources. Hence other objects cannot be seen so clearly, if the principal source of light comes within the field of vision.

For the same reason care should be taken to avoid direct reflection of light to the eye. Hence the familiar rule to have

the light come from over one's shoulder. Reflection is less troublesome from large sources of light than from equally strong ones more intense and smaller.

Failure to recognize the difference between illumination and illumination appearance often leads to serious mistakes in lighting public halls. Frequently it is almost impossible to see the speaker on a platform without squinting between or under lights that blind more than illuminate. The drowsiness that forces itself upon an audience is frequently due quite as much to the brilliancy of the lights as to the dulness of the speaker.

For some purposes it is desirable to combine illumination with illumination appearance. Here again the genius of the advertiser finds a fruitful field. Examples in Minneapolis are the rows of arc lights along the sidewalks in front of the Syndicate Block, the Glass Block, and the Plymouth. The arcs call attention from a distance, and also illuminate the store show windows, being high enough not to interfere seriously with the view of those in carriages, and being above and behind persons on the sidewalk. Rows of incandescent lights along the edges of show windows also serve the double purpose. Fancy designs in the windows themselves are effective, if the individual lights are small, or are used with opal or colored globes.

Electric lights can be much better adapted to a combination of illumination with illumination appearance than gas lights. For illumination without illumination appearance, electric lights also render possible new and improved methods. A very satisfactory way of lighting large halls or workshops is by the use of inverted arc lamps hung several feet below the ceiling. The current is sent in the opposite direction from ordinary practice, so that the lower carbon becomes positive and the upper negative. The crater thus formed on the lower carbon sends most of the light upward against a whitened ceiling, whence it is diffused throughout the room, giving a uniform daylight effect. Suitable reflectors hung below the lamps increase the amount of light sent upward, and also render the direct source of light invisible. Daylight effect may also be obtained by the use of incandescent lamps upon the ceiling, screened by semi-circular porcelain shades underneath. Another method is to hide the lamps above a shelving cornice, or behind a translucent cove, so that only diffused light enters the room. Incandescent lamps almost surrounded by opaque screens are very convenient for desks, reading-tables, or sick-chambers.

Economy in Central-Station Lighting Plants.

THE report of the committee on data of the National Electric Lighting Association (*Engineering News*, May 14) is an important document. It is safe to say that it will attract the attention of electrical and mechanical engineers throughout the world. The bulk of the information in this report is presented in tabulated form, and the data are sufficient for determining the question of economy of power generation. The charts of load lines, of which there are three, have been constructed from thirty-minute readings from meters, or estimated from voltage and amperes.

Economies are presented from eighty-two central stations, some of which are the largest in the country, "five of them having an output of over ten million watt hours per day, and forty-five having an output of from one to ten million watt hours per day." The data compiled from eighty-one central stations show an average efficiency of 108 watt hours per pound of coal. One station uses oil-fuel, and produces 1,117 watt hours per gallon of oil consumed. Steam production did not receive the general attention that was paid to other subjects embodied in the circular of inquiry sent out by the committee. Only thirty-one stations reported upon this point. The highest report was 10.5 pounds of steam per pound of semi-bituminous coal burned; the lowest report is 4.66 pounds of water evaporated per pound of bituminous coal; and the general average of the thirty-one reports is 7.09 pounds of water evaporated per pound of coal burned.

One of the triple-expansion engines averages one indicated horse power with

eighteen pounds of water. The committee concludes that the question of economy is "as much a question of management and manipulation as of the type of machinery used," and, in the final paragraph of the report, repeats "a former statement that the economy secured in generating power for electrical work does not compare favorably with the production of power for other purposes, and that this is also true after taking into consideration the variation in load due to electrical work. Referring to a recent statement of the economy of the Chestnut Hill Pumping Station at Boston, it was found that, in actual water lifted, a horse power was produced by the consumption of 1.34 pounds of coal; allowing that the efficiency of pumps compares favorably with the efficiency of the generators, and making no allowance for variation in load, one pound of anthracite coal used with the same economy in electrical work should produce 557 watt hours." The load line charts "show a fair average of the variation in electrical work, line three, chart one, dropping from 1,800 k-w at 6 P. M. to 250 at midnight; yet the changes seem, as generally true in electric lighting, to be fairly uniform, and a station planned with the proper units for the work should operate the much larger percentage of its generating appliances on a fair basis of economy, bringing the record in this work much nearer the standards of efficiency in other lines."

Electricity in Dentistry.

HEAT compared with other forces in nature with reference to the ways in which they are useful to man is, like water among substances, seen to be essential not alone to life, but to nearly all the activities of life. It would be difficult to name any article in common use, either in manufactures or domestic occupations, for the production or application of which both water and heat are unnecessary. It now seems that electricity, as a force, is likely soon to rank next to heat in importance to man, if, indeed, it does not already take that rank. In nearly all fields of industry it now holds a useful place, and its usefulness grows with the lapse of time.

In medicine and surgery it has had a place for many years, but in that department of surgery known as dentistry its employment is comparatively recent. It is now, however, found to be applicable to wider uses in this art than was formerly supposed possible, and scientific and electrical journals have discussed its possibilities for dental purposes considerably of late. *Electricity* (April 24) and *The Electrical Review* (May 1) each devote considerable space to this subject. Thus far the operation of small motors used for driving grinding-wheels or disks, drills, etc., has been the chief function which electrical energy has found in the art of dentistry; but the operation of tools used for filling teeth is a recent innovation of great value. The process of filling may by this means be much shortened, thus lessening the discomfort of the patient, and the fatigue,—often a more severe tax upon the dentist than upon the person undergoing the operation.

Electricity describes and illustrates an ingenious, though very simple, electric mallet for the consolidation of gold and other metallic fillings in excavated cavities.

An electric hot-air syringe for drying out cavities, etc., is another ingenious device. In this instrument the air passing through a tube is heated by a small platinum electric coil, instead of a spirit lamp as heretofore.

The same paper also speaks of the use of small electric lamps used in connection with reflectors for examining the teeth and the mouth tissues; but this application is more fully dealt with in *The Electrical Review*, which also notes applications of perhaps still greater importance. In this connection, an address of C. H. Guy delivered at a recent meeting of the Central Dental Association at Newark, N. J., is referred to as broadly stating that, "when anesthetics and other drugs are introduced into tissue and into dentine, their familiar topical effects may be vastly enhanced by the aid of electricity. Broadly speaking, he said any drug that has been used previously without electricity within the mouth to produce a specific effect may now be used with tenfold its former power for good.

THE ENGINEERING INDEX—1896.

Current Leading Articles on Applied Electricity in the American, English and British Colonial Electrical, and Engineering Journals—See Introductory.

Lighting.

†5966. Electrical Engineering in Modern Central Stations. Louis A. Ferguson (A lecture delivered before the students in the College of Mechanics and Engineering, University of Wisconsin. The subject is opened by advice for the choosing of a site, and considers the construction of the buildings, equipment, and all phases of the subject. The Harrison St. Station in Chicago is described, and the value of storage batteries explained). Bul of Univ of Wis-Vol. I, No. 8. 13000 w.

*5979. Electrical Stage Effects. Theodore Waters (An interesting, illustrated account of what has been done in electrical stage work, and how the marvelous effects are produced). Elec Pow-May. 6000 w.

*5981. The Middle Age of Electric Lighting. Ralph W. Pope (Historical account of the early development of the electric lighting industry and of some of the difficulties encountered). Elec Power-May. 3400 w.

*6017. On the Alternate Current Arc (Review of a recent paper by H. Gorges, descriptive of investigations chiefly carried out in Germany). Elec Rev, Lond-May 1. 1300 w.

*6019. The Electric Lighting of the Hotel Cecil (Account of the lighting system which will contain more than 15,000 incandescent lamps, most of which are 16 c. p. Some other facts of interest concerning this large hotel are also given). Elec Eng, Lond-May 1. 2200 w.

6038. Results Accomplished in Distribution of Light and Power by Alternating Currents. W. L. R. Emmet (Read before the National Electric Light Assn. A review of the causes for the slow development of the use of alternate currents, and the means of overcoming the difficulties; facts are given showing the hold already taken upon the industry of the country, and the different methods of distributing power and light by alternating currents are illustrated by diagrams showing the connections used with each). Elec Rev-May 13. 5000 w.

6039. Evolution of Interior Conduits from the Electrical Standpoint. Luther Stieringer (Read before the National Electric Light Assn. An examination of the problem with the object of finding a plan of improvement. A brief review of conduits for water, gas and steam is given, especially before the introduction of electric currents. Facts demonstrated by the best experience of the past 15 years in interior wiring are also given). Elec Rev-May 13. 7500 w.

6040. Some Account of the Evolution of the Inductor Alternator. John F. Kelly (Read before the National Electric Light Assn. The first number contains an illustrated description of the machines of Knight, Wheatstone, Lippens, S. M. Martin and S. A. Varley). Elec Rev-May 13. Serial. 1st part. 700 w.

6071. Comparison of Economy of Various Central Station Lighting Plants (Report of the Committee on Data of the National Electric Light Association. Tabulated statement of watt hours produced per pound of fuel, equipment, efficiency, etc., with diagrams showing variations of load under different capacities). Eng News-May 14. 800 w.

*6128 The Combined Alternate-Current and Continuous-Current System of Supply at Brighton (Illustrated description of the system for supplying the outlying districts during the greater portion of the 24 hours with continuous currents, and during the few hours of heavy load with alternate currents. Particulars showing the substantial gain and practical success). Elect'n-May 8. 1100 w.

6151. The Evolution of the Arc Lamp. L. H. Rogers (Read before the National Electric Light Assn. The development is traced from the beginning and the imperfections and difficulties discussed). Elec Rev-May 20. 5500 w.

6152. Tesla's Important Advances (His remarkable achievements in vacuum tube lighting). Elec Rev-May 20. 500 w.

6158. The Industrial Development of Electric Lighting. George R. Metcalfe (Historical review tracing improvements). Elec-May 20. 3000 w.

6176. Equalizer Systems of Distribution. A. Churchward (Read before the N. E. L. Assn. An abbreviated list of methods that have been devised to accomplish the results obtained by the three-wire system without the use of a divided source of electrical energy, and a compensating conductor connected to the point of division). Elec Wld-May 23. 800 w.

*6210. High-Voltage Lamps, and Their Influence on Central Station Practice G. L. Addenbrooke (Paper read before the Inst. of Elec. Engs The first part considers possible sources of influence on central station practice, life of high-voltage lamps, and the effect of using high-voltage lamps on distribution). Ind & Ir-May 8. Serial. 1st part. 4000 w.

6284. The Energy Required in Moore Vacuum Tube Lighting. Nelson W. Perry (Results of tests made by Mr. Wetzler with description of the method of making these tests, with the aim of obtaining data as to power expenditure). Elec-May 27. 1200 w.

*6326. The Electricity Station at the Earl's Court Exhibition (Details of the electric light installation at the India and Ceylon exhibition at Earl's Court, with report on test of high-speed engine). Eng, Lond-May 22. 4000 w.

6391. Interior Wiring (General consideration of the attributes of a good wiring installation). Am Elect'n-May. 1600 w.

*6395. On the Use and Economies of Rectifiers for Arc Lighting. John Hesketh (Abstract of paper read before the Northern Society of

Elec. Engs. Recent experiences in the use of one special form of apparatus and system of generating the necessary energy. The apparatus is described and the points arising from its use discussed). Elec Eng, Lond–May 22. 2800 w.

6408. A Spectroscopic Examination of Moore's and Edison's Lights. Nelson W. Perry (Examination made by the writer, with remarks and reference to similar spectra observed by scientists). Elec–June 3. 900 w.

6435. Charging for Electric Lighting Service. Arthur J. Farnsworth (The writer states the fundamental principles of a desirable system, notes the defects in the common methods, and calls attention to a system in which some of these defects have been removed). Elec Eng–June 3. 2700 w.

6436. Ferraris and Arno's System of Alternate Current Electric Distribution (A new system of electric distribution of energy with alternate currents, which enables them to supply power, in combination with light, from single-phase alternate current circuits). Elec Eng–June 3. 900 w.

*6448. Islington Electric Light Station (Illustrated description). Eng, Lond–May 29. 5000 w.

*6457. The Electric Lighting of Norwich, Eng. (Description of the work with illustrations of the plant). Engng–May 29. 4000 w.

Power.

*5943. The Electric versus the Hydraulic Elevator. Wm. Baxter, Jr. (Showing the cause that led to the development of the electric elevator, and the advantages that point to its triumph in the struggle for supremacy). Eng Mag–June. 3800 w.

*5961. Electricity as Applied to Dentistry. J. Warren (Brief description of some of the devices by which electricity is made useful in dentistry). Elec, Lond–April 24. 1000 w.

*5984. Storage Batteries. Ill. Charles Blizard (An outline of the applications of batteries abroad and a brief account of the more important applications that have been put down in this country during the past two or three years). Elec Power–May. 5300 w.

*6015. Some Possibilities of Electricity in Dental Surgery (Editorial upon speech made by G. H. Guy at the gathering of the Central Dental Assn., at Newark, N. J., showing that the applications of electricity to dental work are constantly increasing). Elec Rev, Lond–May 1. 800 w.

6021. Dynamo Construction. J. B. Hall (A short description and sketches of a two-light dynamo or one-eighth horse-power motor. Of interest to amateur electricians). Can Eng–May. 1300 w.

†6032. On the Alternating Current Dynamo. W. E. Goldsborough (A study, giving general equations that cover the working of alternating current dynamos, with graphical analysis and discussion). Phys Rev–May-June. 1400 w.

*6035. The Bazacle Electric Power Station at Toulouse (A brief description of station). Elec, Lond–May 1. 1500 w.

6067. Electromotive Force, Counter Electromotive Force and Speed (The terms explained and their relation traced). Am Mach–May 14. 1800 w.

6068. The Electric Motor for Intermittent Work (Explaining the steps by which a motor which at first was entirely inadequate to the work of reversal, was made to do the work with entire success—the expedients adopted having the effect of reducing the current at the peak to a point which the motor could carry without difficulty). Am Mach–May 14. 2200 w.

6080. Notes on the Design and Manufacture of Dynamo Electric Machinery. C. H. Chalmers (Treats briefly of a few points in the design and manufacture of dynamo electric machinery, particular attention being paid to considerations which the technical press and text-books regard as of minor importance). Engineers' Year Book–Univ of Minn. 1200 w.

*6127. Long Distance Transmission of Electric Power. T. A. W. Shock (Read before the Street Railway Assn. of California. Brief description of the Folsom works). St Ry Rev–May 15. 1100 w.

6164. Electrical Tests of Power Required by Machines for Working Structural Steel, at the Pencoyd Iron Works (Tests of machines operated by individual motors, and of machines operated by motor and line shaft). Am Mach–May 21. 1200 w.

6165. Counter Electromotive Force, Torque, Current and Field Strength (The relations between electromotive force, counter-electromotive force and the strength of the field magnets are discussed). Am Mach–May 21. 1300 w.

6276. The Electric Motor in Rolling-Mills and Steel Works (A brief description of rolling-mill work, showing the necessity of having power of some sort available almost everywhere, followed by a review of the wide range of application which electric power has already found). Am Mach–May 28. 1800 w.

*6293. The Economical Generation of Power in Central Stations. C. J. Field (Abstract of a lecture delivered at Sibley College. The writer reviews the changes that have been brought about in the design and construction of stations for the development of electric light and power, and the systems and practices that have brought the best results). Sib Jour of Engng–May. 2700 w.

6298. A New Method for Testing Lubricants. Paul MacGahan (Description of a method by means of which original and useful results were obtained during the course of an investigation made in the mechanical laboratory of Columbia University on the various lubricants used for electrical machinery). Elec Wld–May 30. 900 w.

6304. The Reconstruction of the Plant of the Chicago Board of Trade. Bion J. Arnold (Abstract from a paper presented at meeting of Amer. Inst. of Elec. Engs. Illustrated description). Elec Eng–May 27. 2000 w.

6305. The Hayden Century Clock. M. H. Lockwood (Illustrated description of a novel clock and its workings. The clock is run en-

tirely by electro magnets which are actuated by the current from an earth battery). Elec Eng–May 27. 600 w.

†6307. Electric Elevators, with Detailed Description of Special Types. Frank J. Sprague (An interesting paper, with lengthy discussion). Trans Am Inst of Elec Engs–Jan. 29500 w.

6373. Some Problems in Electric Elevator Work. Ill. H. Cochrane (Read before the Chicago Elec. Assn. A review of some of the details of practical construction, showing that the application of electricity to elevator service involves a great many engineering problems). W Elec–May 30. 5300 w.

*6377. A Producer-Gas-Engine Electrical Plant. Albion T. Snell (Description of the power station, gas engine, dynamo, motors, method of distribution and working of the electrical plant of Messrs. R. Maclaren's iron foundry in Glasgow). Elect'n–May 22. 1700 w.

6392. Repair of Electric Railway Apparatus. W. E. Shepard (A description of the General Electric Controller and the repairs). Am Elect'n–May 2. 200 w.

6393. Faults in Dynamos (A few simple methods of attaining certain ends). Am Elect'n–May. 1700 w.

6398. Storage Battery Manipulation on Variable Loads. J. E. Woodbridge (A consideration of the seeming desirability of the storage battery in the trolley line power station, and the difficulties of operation). Elec Wld–June 6. 1000 w.

6399. Regulation of Rotary Current Motors. H. Behn-Eschenburg (Formulas for this regulating, with reasons). Elec Wld–June 6. 1200 w.

6421. The Action of the Series Motor and Generator (The machine is first considered as a motor, and the action of the current explained, followed by a brief explanation of the action of the series machine as a dynamo). Am Mach–June 4. 2200 w.

6443. Electric Elevators in an Elevated Railway Station (Illustrated description of the western terminal station of the Lake St. Elevated Railroad Company of Chicago. Highly appreciated by patrons, but expense prohibits their extension). W Elec–June 6. 600 w.

*6486. The Maximum Efficiency of Transformers. Bernard P. Scattergood (Formulæ are deduced which it is said may be safely used to determine the conditions of maximum efficiency). Elect'n–May 29. 1000 w.

*6488. The Utilization of Water-Power, Especially with a Small Fall, with Some Examples of Plants for the Generation of Electrical Energy. Alph. Steiger (Read before the Inst of Elec. Engs. Showing that the water-powers if judiciously utilized are capable of rendering great service). Elect'n–May 29. Serial. 1st part. 1700 w.

Telephony and Telegraphy.

5960. C. P. R. Telegraph Storage Battery Plant at Ottawa. W. J. Camp (Illustrated description). Can Elec News–May. 1500 w.

*6016. Dynamos for Telegraph Working. W. Slingo and A. Brooker (A suggestion for economizing space. In the Chicago office of the Western Union Telegraph Co., an installation of dynamos has recently been put in to replace 60,000 primary cells, with every indication of success). Elec Rev, Lond–May 1. 2400 w.

*6020. On Railway Telegraphs with Special Reference to Recent Improvements. W. Langdon (Read before the British Inst. of Elec. Engs. The advances are to be found more in minor details than in any radical change. The subject is treated in detail). Elec Eng, Lond–May 1. Serial. 1st part. 2500 w.

6174. Remarkable Feat in Telegraphy (An account of the feat at the N. E. L. A. Exposition, whereby special dispatches over telegraphic circuits, arranged as nearly as possible around the earth, and their receipt at the same place was accomplished within an hour). Elec Wld–May 23. 1800 w.

*6375. Cable Laying in the Amazon River. Alexander Siemens (Abstract of a lecture delivered before the Royal Inst. of Gt. Britain. An interesting account of the experiences and adventures during the voyage of the cable-ship "Faraday" up the Amazon River, last Jan. and Feb). Elec Rev, Lond–May 22. 3500 w.

*6376. The International Telegraph Conference of 1896 (Translation of a circular, written in the French language, and signed "F. Gd." On the necessity of unification of international telegraph rates, with the obstacles. The movements already made to attain this end are reviewed, and a plan suggested). Elec Rev, Lond–May 22. 2000 w.

6496. The Drawbaugh Telephone Case (The Senate Patent Committee favors authorizing the Commissioner of Patents to issue patents to Daniel Drawbaugh. With editorial). Elec Rev–June 10. 1700 w.

†6498. Our Telegraphic Isolation. Percy A. Hurd (The need of a system of telegraphic communication completely under British control. South Africa, India, Australasia and the West Indies are considered and a solution of the difficulty presented). Contemporary Rev–June. 3200 w.

Miscellany.

*5940. Relations of Electrical and Mechanical Engineering. Elias E. Ries (An analysis of electrical engineering, showing the close connection with mechanical engineering of that branch which deals with the design and construction of electro mechanical apparatus). Eng Mag–June. 4300 w.

*5980. The Relation of the Underwriter to the Electrical Engineer. William Brophy (An account of the influence upon the electric lighting industry of the fire underwriters and rules promulgated and enforced by them. The character and efficiency of inspectors is somewhat reviewed, and the opinion is given that the system of electric inspection is of mutual benefit when conducted by men of ability and integrity). Elec Power–May. 3500 w.

*5982. Some Interesting Features (Interesting information in connection with the history

of Electrical Engineering, mostly of a personal character. Photographs and fac-simile letters of prominent electricians). Elec Power–May. 800 w.

*5983. Systems of Units. William Hallock (Abstract of lecture before the Henry Electric Club. A brief reference to the earliest use of units of measure and how they were established, and the system adopted by the French and called the metric system ; also the relation of electrical units to mechanical units is discussed). Elec Pow–May. 2500 w.

†6084 Ground Detection in Electric Circuits. H. M. Wheeler (Brief review of various methods with diagrams). Engineers' Year Book–Univ of Minn. 2000 w.

*6129. Prof. Ewing's Permeability Bridge (A magnetic invention for measuring permeability. The principle of action is to compare the sample to be tested, step by step with a standard bar, the B-H curve of which has been previously determined once for all). Elect'n–May 8. 1100 w.

*6130. Some Electric Supply Data (Diagrams showing percentage loss of energy in distribution in some electric supply systems, percentage load factors, percentage maximum demand factors, and tables showing the distribution efficiency, load factors and maximum demand factors, and a comparison with generating expenses and costs). Elect'n–May 8. 800 w.

6205. Direct Conversion of Carbon into Electrical Energy (Illustrated description of the patent of William W. Jacques). W Elec–May 23. 1400 w.

*6247. Experimental Tests on the Influence of the Shape of the Applied Potential Difference Wave on the Iron Losses of Transformers. Stanley Beeton, C. Percy Taylor, and J. Mark Barr (Read before the Inst. of Elec. Engs. An account of some fairly complete experiments on this subject, which were carried out at the Central Technical College, about one year ago. Work of previous investigators is reviewed, apparatus described, etc., in part first). Elect'n–May 15. Serial. 1st part. 3000 w.

6285. An Analysis of Transformer Curves. Charles K. Huguet (Paper presented at the 13th general meeting of the Amer. Inst. of Elec. Engs. Experiments conducted by the writer at Tulane University to investigate a question, which had been subject to an apparent conflict of opinion, by analyzing the current curve into its various components). Elec–May 27. 1600 w.

6286. Electrolysis. William Brophy (Topic discussed before the National Electric Light Assn. A review of the causes that led to placing wires under ground and the difficulties met with. The causes of electrolysis and the remedy). Elec Rev–May 27. 3500 w.

6301. The Paris Electrical Exposition of 1881. William J. Hammer (The important exhibits are recalled and the effect produced on all branches of electrical development). Elec Wld–May 30. 1500 w.

6302. The Crystal Palace Electrical Exposition of 1881-82 (A brief account, especially noting the more complete representation made by the English). Elec Wld–May 30. 500 w.

6303. Effect of Temperature on Insulating Materials. George F. Sever, A. Monell and C. L. Perry (Conclusions drawn from 102 tests on samples of materials, which were furnished by several of the most prominent manufacturers of electrical machinery). Elec Wld–May 30. 3800 w.

*6345. Practical Notes on Underground Electrical Service. E. J. Spencer (A review of the history of underground wiring, its failures and final success. The systems in use for underground wiring are explained, and matter of interest regarding cost, etc., is given). Jour of Assn of Engng Socs–June. 5000 w.

6394. A Biographical History of Electricity (Introductory remarks, and biographical history of William Gilbert, of Colchester, are given in part first). Am Elect'n–May. Serial. 1st part. 1700 w.

6397. An Electromagnetic Theory of the Inertia of Matter. Edwin J. Houston and A. E. Kennelly (The ideas presented are novel and the article is interesting). Elec Wld–June 6. 2000 w.

6407. Dr. W. W. Jacques' Carbon Electrical Generator (Editorial comment drawing the conclusions that (1) the air blast must consume a very large proportion of the total energy of each cell. (2) That in addition to a very expensive form of fuel there must be added the cost of fuel required to keep the electrolyte fluid under very trying conditions. (3) That the electrolyte must be replenished as in other batteries). Elec–June 3. 900 w.

†6426. Mechanical Conceptions of Electrical Phenomena. A. E. Dolbear (The first part traces the progress of mechanical knowledge from the time of Newton). Jour Fr Inst–June. Serial. 1st part. 4500 w.

†6427. Inherent Defects in Fuse Metals Experimentally Considered. Walter E. Harrington (Considers in detail, and demonstrates by tests, some of the defects in fuse metals which condemn them as a safe and reliable means for protecting electric circuits from unusual and abnormal conditions). Jour Fr Inst–June. 3000 w.

6437. The Edison Fluoroscope Exhibit (A description of this exhibit at the Electrical Exposition in New York). Elec Eng–June 3. 1300 w.

*6463. The Magnetic Properties of Iron and Steel (Brief abstracts of two papers by J. A. Ewing and H. F. Parshall. Read before the Inst. of Civ. Engs. The practical importance in relation to the manufacture of dynamos and transformers is referred to, and a permeability tester is described). Engng–May 29. 1000 w.

6484. The Inventions of Nikola Tesla. From the *N. Y. Sun* (A brief review of what he has accomplished). Prog of the Wld–June. 1100 w.

6497. Electrical Features of the New National Library at Washington, D. C. George H. Draper (Description of the electrical installation, together with some observations on the boiler plant and other apparatus in the building). Elec Rev–June 10. 1600 w.

We supply copies of these articles. See Introductory

INDUSTRIAL SOCIOLOGY

Recent Legislation in Restraint of Trade.

THE inherent weakness and inutility of existing and recent statutes in restraint of trade are pointed out by Charles F. Beach, Jr., in *The American Journal of Sociology* for May. The author also shows that legal precedents bearing upon what jurists style public policy are fallacious, because, as civilization advances, public policy changes as social conditions change. What might have been good public policy in the reign of Henry VIII is likely to be the very reverse in the United States at the end of the nineteenth century.

The position is taken that, "for all practical purposes, whether those of the student, the legislator, or lawyer, restraint of trade and prevention of competition in trade are substantially equivalent, and are governed by the same principles." In this proposition the word "trade" is taken in its broadest sense, as including "not only the dealing of merchants, but the business of railroading, insurance, and manufacture, and the greater part of all contractual relations between man and man in a civilized community." Legislation affecting these relations will therefore "include statutes regulating the practice of medicine and of law; statutes of patent and copyright; usury laws; Sunday laws; laws regulating the sale of intoxicating liquors at retail; laws regulating the operation of mines; laws against champerty and maintenance; taxation of commerce, and particularly, in this country, of interstate commerce; 'drummers'' taxes; laws attempting to regulate dealings in futures, forbidding wager policies on human life, prohibiting the operation of lotteries, and all that large body of legislation by which the regulation of labor is attempted."

A famous English judge is quoted as saying that "public policy does not admit of definition, and is not easily explained." A decision in an English case is cited as saying of public policy that it "is a very unruly horse, and, when once you get astride of it, you never know where it will carry you." In a recent English case it was also said that "public policy is a variable quantity; that it must vary and does vary with the habits, capacities, and opportunities of the public." Many more quotations to the same effect lead up to the expression of a belief that no fixed rule of public policy can be established.

"Conceding, or, better, realizing, this inherently fluctuating character or quality of public policy, we see that the enactment of statutes to declare or define it must of necessity be a dangerous business, because such statutes, however accurately they reflect the public policy of the moment of their enactment, must almost immediately begin to be wrong. The common law, reposing, according to the legal fiction, in the bosom of the court, is flexible, and can change or be changed, as we have seen, with the change of condition; but a statute stands rigid on the statute-book, and is the same thing yesterday, to-day, and forever; so that it must be amended, or repealed, or modified, or disregarded in the progress of time, as conditions change, in order not to be quite out of tune and touch with the orderly progression of things. This is something which the rural legislator, in his zeal to pass laws upon the subject of trade, seems entirely to have overlooked. Accordingly this inexorable fact has been the undoing of his work. By reference to the law books, he is informed with sweeping generality that, at common law, monopolies are illegal and void. If he be industrious and curious, and reads Norman French, he finds out that, as early as the reign of Henry V, in the year 1415, a case, which seems to have been the first case of the sort, arose, in which a dyer had bound himself not to exercise his trade for half a year in the same town with the plaintiff. In an action on the bond, this was held to be an unlawful agreement, as in restraint of trade. This case was decided long before there was any statute on

the subject, and from it has come down to us, in ordinary generation, a long line of decisions upon the general question there involved."

Patents and grants, in the nature of monopolies, followed later, the practice dating from about the time of Henry VIII. In the reign of Elizabeth monopolies were declared illegal at common law. This declaration, often quoted within a recent period, is held by Mr. Beach to have no present force.

"In a legal sense, monopoly, at the present day, simply means the obtaining, without a grant from the sovereign, of the exclusive power to carry on a certain trade or business. In a proper sense, the term monopoly is applied to every large and successful business enterprise; and some statutes, as, for example, the proposed legislation in Illinois against department stores, go so far as to seem to proceed upon the notion that, because an enterprise has attained large proportions, it is, in a legal sense, a monopoly,—*ergo*, unlawful. Railways, national banks, and corporations of all kinds are, in the view of that part of the public in sympathy with such legislation as this, obnoxious as monopolies."

Of the dread of monopoly Mr. Beach says: "Englishmen—and by Englishmen we must include ourselves as of the Anglo-Saxon stock—have always had what they have hugged to their hearts as a 'wholesome dread of monopoly.' No Englishmen ever knew, and no one of us can ever know, exactly what 'monopoly' in this precious phrase means; but that it means something to be dreaded no really sound Englishmen ever doubted. It is a sort of bogey that has served to scare a hundred generations of us. So also, as of course, very much of the recent agitation which has arisen over monopoly, and which has provoked for the past six or eight years a flood of legislation and litigation in the United States in restraint of trade, is the outcropping of the grudge which the 'have nots' always have against the 'haves.' It gave the politicians a chance, of which they were not slow to avail themselves, and of which they have made the most. It is a significant fact that during the same period of time when our legislatures, including the federal congress, have been going off upon a quasi-medieval tangent, the courts have for the most part been unswerved, and have in no notable instance been carried off their feet by the popular clamor. A great number of suits have been brought, in which it has been sought to commit the courts to the same radical views upon the subject which have been enacted into statutes, and in which it has been sought to secure adjudications upon the economic questions involved—for the most part without success. And it is, I repeat, creditable to the courts that this is so."

It is alleged that "the courts, in a great number of cases, have reflected more accurately than the statutes the public policy of the times." Mr. Justice Barrett is praised for having, in the face of popular clamor, laid down the principle that "competitive contracts to avert personal ruin may be perfectly reasonable," and that "only when such contracts are publicly oppressive they become unreasonable and are condemned as against public policy." Upon this principle it is the effect of any monopoly upon the public, and not the mere fact that it is a monopoly, that renders it bad or good as public policy.

In conclusion, it is maintained that most of the legislation upon the subject during six or eight years has been in a temper not conducive to sound legislation; that it is, moreover, "unscientific, impolitic, and fatuous"; that it will not endure, but will go on record "as a monument to the over-zeal of ill-instructed or half-instructed legislators."

The Investors' Dilemma.

THE above is the title of an unsigned article in *The Bankers' Magazine* (London) for April, and the following abstract contains some of the interesting points brought out. Of course, these views are from an English standpoint, but they merit attention.

In spite of the present situation, presenting much that is by no means new or even perplexing, we may well feel that at the present time we are, in many respects

at least, passing through a period of "records" in the financial world. We have now experienced the longest spell of the easiest money ever known since statistics on the subject were first compiled. The Bank of England rate has stood at the minimum of two per cent. for more than two years. Consols and other investment stocks have attained to heights hitherto unknown, while side by side we have recently witnessed the most gigantic speculation in mining shares ever known.

Never before probably was there a time when everyone was more genuinely perplexed as to "what to do with his money." For a few years past this perplexity has been experienced to a full degree by bankers, who have—in spite of the reduction of interest on deposits from 1 to ½ per cent., —found ever-increasing difficulty in profitably employing the balances at their disposal. But now that perplexity is not confined to bankers or the financial community. Everywhere, and on all sides, the problem of an ever-increasing dearth in investment securities yielding a fair return of interest is pressing for solution. Bankers are being continually harassed by solicitations from their customers to invest their surplus cash in something "sound," but yielding from 3 to 3½ per cent. A few years ago such a commission could have been executed in a moment. To-day it is a most difficult task.

British government securities seem to be fast approaching a 2 per cent. basis. English corporation stocks are mostly at prices yielding little more than 2½ per cent., and the same may be said of the debentures of English railways, on which 2⅝ to 2¾ per cent. is now an average yield at present prices.

Neither a solution of the problem thus presented or prophesies as to the probable duration of this plethora of money are attempted. "Even among those who live and move amongst the facts of every-day finance, many are constantly manifesting, in divers ways, that to account for much in the present situation baffles their ingenuity. Why, for example, is it that, with so many millions swept from the market and 'locked up' at the Bank to the credit of Japan, money should still be a 'drug' in the market? True it is that much, and even most, of the Japanese money has been withdrawn from the continent; but this has, again, to some extent, taken the form of lessening continental balances in London. Yet again: why is it, with confidence and credit restored, that money should be more unsalable even than during the period of dullness and stagnation following upon the Baring crisis in 1890?

"That this state of things is the result of the action of economic laws cannot be doubted, and a moment's thought will convince the most superficial observer that the present phenomenally high level of public securities is due more to expansion —we might almost say an inflation—of credit than to the lack of other outlets for cash or other causes which might be assigned."

Whatever may be the numerous causes of this credit boom, it is not satisfactorily proved that the increased output of gold is a potent factor in it. Among the causes, some more obvious than others are thought to be "the comparative lack of any adequate outlets for money; the heavy fall in prices of commodities (due as much to competition and economy in industry as to any other cause); . . . and the financial unrest in America . . . . Credit is but the expansion and the earnest of wealth possessed in some form or other, and this wealth is not only misrepresented by, but is almost apart from, the question of the supply of gold."

The Irrepressible Conflict Between Gas Companies and Municipalities.

WE make the following abstract from an address by General Andrew Hickenlooper before the nineteenth annual meeting of the Western Gas Association, held at Chattanooga, Tennessee, May 20 and 21, 1896, the full text of which is printed in *American Gas Light Journal* (June 1). The address sets forth the relations of incorporated companies to the public in a clear and concise way, and is a powerful argument in favor of regulated corporate monopolies as opposed to municipal control of industries supplying the inhabi-

tants of cities with any necessity of urban life.

After a brilliant tribute to the pioneers of the gas industry, the speaker said that for more than eighty years there has been an irrepressible conflict between municipalities and gas companies as to their respective rights, and he formulated what may be styled a creed of economics, applicable to the mutual relations of corporate companies and municipal bodies.

"I believe in the sacredness and inviolability of contracts, and the supremacy of law. I believe that wisdom and intelligence should govern ignorance and superstition with a firmness and decision that cannot be misunderstood. I believe in absolute equality of taxation; no one character of industrial enterprise should be taxed in excess of that of any other industry simply because it supplies a public want. I believe in the granting of properly-conditioned non-terminable franchises for the supply of a perpetual want. I believe in the establishment of regulated industrial monopolies for the performance of any public service that can be as well or better performed than it can be through municipal agencies. I believe that both gas companies and municipalities have obligations that should be observed, and rights that should be respected."

The speaker then proceeded to consider the nature of a monopoly, and the nature of a corporate company, showing that a municipality is also a corporate body, differing in no essential from other corporations. A monopoly is the possession of a privilege or right of exclusive sale, either through engrossment or grant. A virtual monopoly is defined as being a business so related to the great channels of trade and commerce that it becomes in a measure equivalent to a legal monopoly. A regulated monopoly is one which to a certain extent partakes of the nature of a virtual monopoly, and is yet further controlled and governed by legislative or municipal restrictions.

Corporations are artificial persons created by, or under, authority of law from a group of natural persons, and having a continuous existence, irrespective of that of the persons composing it. There are various kinds and characters of corporations, all having one common object,—*viz.*, the accomplishment of some special purpose which can be more conveniently, efficiently, and economically performed through the instrumentality of such an organization than by individual effort.

A municipality is a municipal corporation, a body formed by authority of the State, authorized to act in an individual capacity through centralized power for the purpose of enhancing and protecting the best interest of the members—citizens—of the municipality.

A gas company is a joint-stock corporation, a body formed by authority of the State, and empowered to act in an individual capacity through centralized power for the purpose of protecting and enhancing the best interests of the members—stockholders—of the corporation.

Both gas companies and municipalities derive their powers from the same source and are subject to the same laws, and their governments are substantially the same. Wherefore, then, should one be preferred to the other? If one is to be preferred, what reason can be assigned for the preference? The answers are found in differences in the characters of the men who respectively manage each class of corporations,—a difference that will exist so long as men are chosen for officers in private corporations for their known business ability and probity, and in municipal corporations chiefly on account of their political pull and skill in controlling elections. Business ability and probity are very rarely found joined with political pull. One has only to consider the nature of things to understand this fact,—one of the most conspicuous in history.

The plain common-sense business man is probably not always as intelligent as he should be in regard to municipal needs and requirements; but he "is generally guided in his course by a sincere desire to be fair and honest." The "representative of the purely political element in a community—usually the brightest, best-posted, and most skilful controller of public sen-

timent," and adroit "manipulator of legislative proceedings"—is "by all odds the best equipped for good or evil," but he is "usually unmindful of the grave and responsible duties of true citizenship, when . . . studying party interests, or the possible effect of any measure which has not . . . the approval of the men upon whom he depends for political preferment." The one labors for the good of the organization of which he is a part and which he represents; the other considers only his own political interests, making these his paramount motives of action. It is not, therefore, difference in fundamental law that makes municipal control of industry objectionable, but difference in the way public and private affairs are, and are ever likely to be, administered.

Paternalism Opposed to Labor Interests.

COMMENTING upon the bill introduced by Representative Sperry, of Connecticut, providing for the classification of clerks in first and second-class post offices, and upon the fact that this bill was introduced at the request of the National Association of Post Office Clerks, *Gunter's Magazine* for June says that the object is not unreasonable, and thinks the bill ought to pass. The bill is directed to the classification of the various workers in the post office in such manner "that they shall have the advantage of promotion from the minimum to the maximum, which now applies to letter carriers."

The New York *Sun* having opposed the measure "on the ground that it is a dangerous precedent to have an association or trades union among federal officeholders," *Gunter's Magazine* makes the following comment upon the *Sun's* argument:

"According to this, the employees of the government are not to have the same opportunities of exercising associated influence to improve their pay that is conceded to all other laborers.

THE ENGINEERING INDEX—1896.

Current Leading Articles on Industrial Sociology in the American, English, and British Colonial Magazines, Reviews and Engineering Journals—See Introductory.

†5956. Recent Legislation in Restraint of Trade. Charles F. Beach, Jr. (The inherent weakness and inutility of existing statutes in restraint of trade are pointed out. It is also shown that as civilization advances, public policy varies in accordance with varying conditions; and that what might have been good public policy in the reign of Henry VIII, might be the reverse in the United States, at the end of the nineteenth century). Am Jour of Soc–May. 6500 w.

†5957. Profit Sharing in the United States. Paul Monroe (An account of results in some fifty different establishments in the United States wherein the experiment of profit sharing has been tried. Some successes and many failures are recorded, and reasons both for success and failure are assigned. The conclusion is that such a system will succeed only with a select few of employers and with a certain grade of skilled or intelligent labor; and that from the point of view of social progress, the system is of little, if any, importance). Am Jour of Soc–May. 11000 w.

†6026. Co-operation in Agriculture. Egerton of Tatton (The question "How far is co-operation in agriculture practicable as a remedy for present agricultural distress?" is answered by a history of organized co-operation in various European countries in the agricultural industries. The article contains a fund of interesting information). Nineteenth Cent–May. 5000 w.

6064. Market Prices and Competition.—Their Origin and Suggestions for Remedying their Evils. Franklin L. Sheppard (An effort to find out the causes of the injurious competition in the stove trade, and to suggest remedies). Ir Age–May 14. 3000 w.

*6111. "Black Lists" (Abridged report from the London *Times* of the recent Trades Union case, in which Messrs. Trollope and some of their workmen brought an action against the London Building Trades' Federation for publishing a "black list"). Arch, Lond–May 8. 4000 w.

6150. Review of the American Iron Trade in 1895; and in the First Four Months of 1896. J. M. S. (From the Annual Statistical Report of the American Iron and Steel Association for 1895. Improvement in business and increase in prices, accompanied by general advance in wages of iron and steel workers, coke workers, and coal miners). Bul of Am Ir & St Assn–May 20. 3000 w.

6198. Business Men on the Sound Money Issue (Editorial remarks discussing and approving the attitude of the Savings Banks' Association (N. Y.), the Cotton Exchange (N. Y.), and the business men of the country generally on the sound money issue). Bradstreet's–May 23. 1000 w.

6199. Bill Restricting Immigration Passed by the House (Editorial comment upon the

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McCall bill which provides for an educational test). Bradstreet's–May 23. 500 w.

*6219. Continental Competition. William Jacks (Paper read at meeting of British Iron Trade Assn. Abstract of a general review and discussion of the situation and of the economic conditions of the British and continental iron industries). Engng–May 15. 4500 w.

†6228. The Sweating System. Henry White (What it is. Legislation relating to its regulation and suppression, and other general considerations). Bul of Dept of Labor–May. 9000 w.

†6229. Recent Reports of State Bureaus of Labor Statistics (Summaries of reports of bureaus, Massachusetts, Missouri and Utah). Bul of Dept of Labor–May. 2200 w.

†6230. Recent Foreign Statistical Publications (General report on the wages of the manual labor classes in the United Kingdom, with tables of the average rates of wages and hours of labor of persons employed in several of the principal trades in 1886 and 1891). Bul of Dept of Labor–May. 5000 w.

†6231. Annual Statistical Abstracts (Tables of contents of abstracts or summaries of results of inquiries made by various bureaus by different governments throughout the world). Bul of Dept of Labor–May. 2500 w.

†6232. Decisions of Courts Affecting Labor (Current decisions in the different States briefly summarized). Bul of Dept of Labor–May. 12000 w.

*6234. The Democratization of England. Thomas Davidson (The change going on in England for the last thirty years and toward democratization, is reviewed, and its causes are found to be (1) economic, (2) literary, (3) ethical, (4) philosophic. The most prominent associations acting to bring about this change are named, and the character of the work of each is described. The England of the future, so far as its features can now be discerned, is outlined). Forum–June. 4500 w.

*6258. The Recovery of Our Industrial Supremacy in the Trade of Ironmaking. B. H. Thwaite (Showing that the natural advantages of England in this field are unrivalled, and examining the causes for alarm and for inability to compete with other countries. The cost of carriage, and the difficulties with British workmen are considered of greatest importance). Ir & Coal Trs Rev–May 15. 1800 w.

*6265. Labor Legislation in the United States. Horace G. Wadlin (The labor legislation is roughly classified under three heads; (1) those affecting the health education and moral welfare of the worker; (2) those insuring personal safety in the performance of work; (3) those enforcing duties and obligations between the employer and employed) Chau–June. 3700 w.

*6266. Labor Unions in China. Walter N. Fong (Interesting account of these unions and their objects, and peculiarities). Chau–June. 2700 w.

†6267. English Industries and German Competition (Superior technical training, not cheaper labor, is held to be the secret of Germany's capacity to compete with English industry). Consular Repts–June. 900 w.

†6268. German Advertising in Japan (Account of a new German trade paper, printed in Japanese, and of the exceedingly strong effort now put forth on the part of Germany to secure Japanese and Chinese trade). Consular Repts–June. 700 w.

*6269. The Italian Woollen Industry (Particulars derived from an official publication of the Italian ministry of agriculture, industry, and commerce). Bd of Tr Jour–May. 2000 w.

*6270. British Trade With Egypt (From a report of Mr. Rennell Rodd, Her Majesty's Secretary of Legation at Cairo). Bd of Tr Jour–May. 4000 w.

*6271. The American Sardine Industry (Interesting details of a flourishing trade). Bd of Tr Jour–May. 1100 w.

*6272. Foreign Competition with English Interests in Japan (Review of a report by Mr. Gerald Lowther, British Secretary of Legation at Tokio). Bd of Tr Jour–May. 2800 w.

*6273. Argentine Republic Customs Law (Translation of full text of the law). Bd of Tr Jour–May. 1800 w.

*6274. Tariff Changes and Customs Regulations (Includes Russia, Sweden, Germany, Belgium, France, Algiers, Portugal, East Africa, Spain, Italy, Roumania, United States, Nicaragua, Mexico and the Bahamas). Bd of Tr Jour–May. 7500 w.

6356. Municipalities vs. Gas Companies: Their Reciprocal Relations. Andrew Hickenlooper (It is shown that private companies are subject to the same governmental control as municipalities, but that the latter have less opportunity and are, therefore, less likely to evade law than municipalities). Am Gas Lgt Jour–June. 15000 w.

†6365. The Outlook for Silver. Dr. Otto Arendt (The views of one of the ablest German advocates of bi-metallism are presented in this article). N Amer Rev–June. 8000 w.

*6367. Bishop Potter as an Arbitrator (Editorial review of Bishop Potter's action as arbitrator in the recent strike of lithographers in New York city. In the main, commendatory). Gunton's Mag–June. 2000 w.

*6368. The Groningen Land Lease System. James Howard Gore (This interesting article was written in the belief that the subject of perpetual leases, as exemplified in the Groningen land lease system, has not before found a place in American sociological literature). Gunton's Mag–June. 3000 w.

†6370. Architects and Trades Unions. Dankmar Adler (The relation of the architect to the unions, and the necessity of employing union labor when buildings are to be completed on time contracts). In Arch–May. 1400 w.

6442. The Bad Citizenship of the Good Citizen. George W. Ochs (All our municipal ills are herein traced to the failure of the better class of citizens to take their full share in active municipal government). Public Opinion–June 4. 1400 w.

We supply copies of these articles. See introductory.

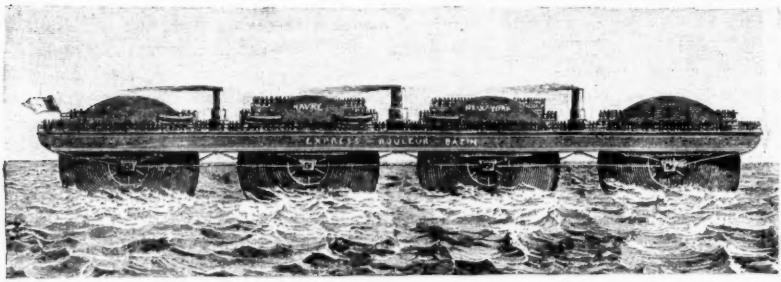
MARINE ENGINEERING

The Bazin Disc-Wheel Steamboat.

THE device described herein (*The Engineer*, London, May 15) must not be confounded with the boat on rollers, which is a very ancient device, or with others of more recent date, as it is believed to be a new departure. It has the rollers in common with its predecessors, but in the method of propulsion it is very different. Boats on rollers have been pushed forward with various means of propulsion. Many of them have had revolving rollers with floats or paddles; but no one up to this time, except M. Ernest Bazin, appears to have conceived the idea of moving such a boat by a propeller independent of the rollers or wheels, and at the same time rotating the wheels, the latter not propelling at all, but simply rotating in relation to the forward movement of the boat.

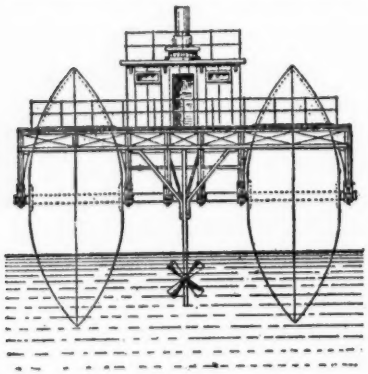
He was led up to this idea by the following experiments: "First, a hollow wheel was placed in a tank, and it floated vertically with about a third of its bulk immersed. Spun round without any forward movement, the wheel continued to revolve for some time without moving from its place, and this proved to M. Bazin that he could not rely upon the revolution of the wheel alone for the propulsion of the vessel. He then pushed the wheel forward without revolving it, and the effect was exactly the same as with an ordinary keel,—that is to say, it threw up a good deal of water in front, and left a trail behind. Moreover, it only advanced four or five feet, and did not show the slightest tendency to revolve. This convinced M. Bazin that he would have to give to the wheel both a revolving and a forward motion. Thereupon, spinning the wheel and pushing it forward, the hollow disc travelled the whole length of the tank with scarcely any agitation to the water whatever. Still pursuing the experiments, the inventor gave a more convincing illustration of the absence of any resistance and friction with the revolving disc. Two sticks were placed in the water, and a disc was propelled horizontally. On meeting the sticks, the wheel pushed them forward a few inches, and then stopped. Repeating this experiment with a revolving disc, the wheel passed over the sticks, which sank under the wheel and rose at the identical place, while the disc continued its course to the end of the tank. After thus proving that the wheel must have both a revolving and a forward movement, M. Bazin soon found that nothing was to be gained by revolving the disc too quickly, and that it was merely necessary to do this in proportion to the propelling force of the screw. If anything, too much power upon the wheels would be likely to cause a certain amount of friction. Under these circumstances, the relative power upon the propeller and the wheels would have to be calculated with a certain nicety, as the discs would have to turn in exact proportion to the distance covered by the boat. This fact having been settled, M. Bazin proceeded to demonstrate the stability and speed of the wheels. A framework carrying six disc wheels, three on each side, was placed in the tank. A cord was attached to it and drawn up over a pulley, and carried a weight of 200 grammes, which represented a certain propulsive force. The frame was pulled back to one end of the tank, and allowed to go forward by the action of the weight at the end of the cord. According to the watch, the time occupied in travelling the whole length of the tank was twenty-three seconds. The same experiment was then repeated with the wheels revolving by clockwork, and, though losing two or three seconds at the start before getting up full speed, the apparatus went from one end of the tank to the other in eleven seconds. By comparing these results, M. Bazin estimates that the speed of a disc-wheel steamboat would be 31 or 32 knots, while the smaller power required results, according to his estimate, in an economy of about 66 per cent. of

coal. One of the advantages claimed for the system is the practical impossibility of sinking. Supposing that one or two, or even more, of the wheels were perforated in collision, the vessel would not do more than sink a few feet,—a fact which was exemplified by removing the plugs from two of the wheels, and allowing the water to enter. As soon as the water had entered to a certain height in the wheel, it turned up with the orifice at the top, thus permitting of the damage being repaired with the greatest ease. Meanwhile, it would be possible for the vessel to proceed at reduced speed."



BAZIN DISC-WHEEL STEAMBOAT.

An exhibition of a working model, built



to one-twenty-fifth the size of a proposed transatlantic boat (to be one hundred and twenty meters long) was recently made by M. Bazin at his Levallois works. "The deck or platform represents a height of six or seven meters above the sea, while the upper deck is about 13 meters above the water level. The deck itself is built up with girders, and, being hollow, it has an enormous carrying capacity, either for merchandise or coal. There are eight discs or floats, four on each side, and, owing to their convex form, they offer little resistance to the wind, while the head wind has a clear passage underneath the deck. In appearance the model is very elegant, and certainly destroys any prejudice that might be entertained against the form of the vessel. The motive power was supplied by dynamos, one working the propeller and four others turning the floats. Upon the connection being made, the propeller revolved with great rapidity, and the wheels turned slowly, and, after a few seconds lost in getting under weigh, the model sailed the whole length of the basin at great speed. To show the conduct of the vessel in rough weather, the water was agitated to represent waves, on the same scale as the model, of five to seven meters in height, and, though rolling slightly at her moorings, the model behaved splendidly when in motion. The miniature waves rose nearly to the level of the deck, but the model rode as steadily as in the previous experiments. It is claimed that in the roughest weather the passengers would feel very little movement of the vessel. In the experimental boat now being constructed the steering is done with an ordinary rudder, but it is proposed to steer the transatlantic vessels by means of a column of water forced out of the stern by a pump, so that, instead of the progress of the vessel being impeded by the resistance of a rudder, it will be assisted by the water

thus expelled at the stern. On the boat taking up its berth, it may be driven by the steering gear alone, and this acts, it is alleged, so efficaciously that the vessel can be turned round its own length."

Admiral Coulombeaud, who is reputed to be one of the first of French naval authorities, is said to be a firm believer in the possibilities of M. Bazin's invention. A boat of this kind, of a size sufficient for the channel passage between France and England, will probably be launched in July, and make its trial trip very soon thereafter.

The first of the illustrations accompanying this description is intended to show a side view of a transatlantic vessel of this sort. The second is a diagrammatic end-view, showing the way in which the deck is supported by the axles of the wheels. It is asserted that Admiral Coulombeaud has computed that only one-twenty-seventh of the power required to drive an ordinary boat is needed for a Bazin craft of the same size and speed.

All this will be regarded with much reserve, until an actual trial shall prove the system to be practical or otherwise.

Mineral Oils in Marine Boilers.

AN editorial dealing with this subject (*Engineering*, London, May 22) contains so many interesting particulars that we recommend its perusal to all steam engineers, whether stationary, locomotive, or marine. Marine engineers, who are obliged sometimes to use salt water as supplementary feed, will, perhaps, be more interested than others.

The instances of collapse of boiler furnaces during the last fifteen years are noted, and the tendency to refer this to the use of mineral oils for lubrication, as the ultimate cause of the mischief, is mentioned. It is a curious fact that most of these collapses have occurred in new steamers.

Animal and vegetable oils were supplanted by mineral lubricants, because the former were deemed injurious to boilers; but, if, as many now suppose, the mineral substitute is also injurious, there is reason in the practice of running engines without lubrication of cylinders or piston rods, these being the parts which, when lubricated, introduce the oil into the steam passages whence it finds its way to the boiler.

In the multiple-expansion engines oil is mostly introduced by the low-pressure piston rod, partly because of the vacuum, and partly because the packings are slack. The latter cause could be rendered less effective by tightening the glands, but there are practical difficulties in the way of applying this method.

"Leakages at the high-and mean-pressure glands are at once detected on account of the escaping steam, but the low-pressure glands have to be tightened up by guesswork; and to be on the safe side the engineer does not go too far. It would also seem as if the low-pressure piston-rod, perhaps on account of its comparatively low temperature, has a tendency to get covered with a sort of greasy scale, which unquestionably assists in abrading the packing. Both these difficulties might be overcome, if the bushes of these glands could be made a good fit around their respective piston-rods, and could be maintained in this condition; but this is practically impossible on account of the large amount of play which exists between the guides and crosshead shoe when the engine is hot."

The use of oil filters for feed water, even by those who no longer lubricate cylinders, is deemed practical proof that the oil introduced by the piston-rods is not negligible. An interesting recital of the conditions in which boilers are found follows, for the full text of which the article must itself be consulted. A hint at the probable cause for the collapsing of furnaces in new steamers is given.

"If much oil has been let into the boiler, the whole internal surface is distinctly greasy, and the water level is filthy. One or the other of these two last conditions is the most likely one to exist in new steamers; and, as it is new steamers which have most frequently collapsed their furnaces when neither ordinary scale was on the plates nor salt in the water, it is but natural to suppose that these mishaps have been caused by the thin film of grease

and rust. In its charred, or semi-charred, condition mineral oil probably partakes more and more of the non-conductive properties of its near relative, hard paraffin, or possibly, under the conditions of high pressure and temperature, it may possess the property of swelling out into large bubbles containing superheated steam or hydrocarbon vapors, and covering the heating surface. In either case the heated plate between this film and the fibre is robbed of all cooling contact, it gets hotter and hotter, and collapses if it forms part of a furnace."

A more reasonable explanation is, however, found in the high non-conductive properties of the greasy film. Other considerations seem to indicate that neither of these explanations is of itself adequate. One of these is the inexplicable fact that "it is rare to find only one furnace in a boiler which comes down, or that the furnaces of one boiler only have come down, but, on the contrary, all the furnaces of all the boilers usually come down together."

Suez Canal Traffic.

RECENT authoritative detailed statistics in the *Board of Trade Journal* (London) for May show that the percentage of British vessels using the Suez canal has been falling off since 1893; there has been also a steady decrease in the total traffic. The figures for the total are 2,318 ships in 1895, having a tonnage of 8,382,075; 2,386 ships in 1894, having a tonnage of 8,326,826; and 2.405 ships in 1893, with a tonnage of 7,-977.728. It is thus seen that, while the number of ships is less, the tonnage has slightly increased. The percentage of British tonnage was $74\frac{9}{10}$ in 1893, $73\frac{8}{10}$ in 1894, and $70\frac{8}{10}$ in 1895. The percentage of German tonnage has increased. The number of ships passing through the canal during the month of February last was 276, of a gross tonnage of 970,066 tons, 258 of which showed a tonnage of 868,714 tons. Of these vessels 171 were English (637,658 tons), 28 Italian (82,391 tons), 24 German (82.100 tons), 18 French (68,677 tons) 17 Dutch (43,103 tons), 7 Austro-Hungarian (23,411 tons), 5 Spanish (20,740 tons), 2 Russian (8,148 tons), 3 Ottoman (2,614 tons), and 1 Norwegian (1,224 tons).

The Forban Criticised.

THIS small French vessel,—the fastest ever put in the water (she made 31 knots per hour)—while she is admitted to be a credit to her constructor, M. Normand, is still criticised by practical men as little more than a marine toy, of no significance as regards the future of either marine warfare, or of marine passenger traffic. A boat 144 feet long, and carrying 4000 horse power to make the speed named seems altogether preposterous except perhaps for some special service in marine warfare.

A correspondent of *The Engineer* (London) puts the vessel on its proper footing as a scientific toy rather than a practical seagoing vessel, and leaves it for naval officers to conjecture what possible useful purpose such a boat could be made to subserve. At the same time he admits that the performance of the boat is admirable, much better than that of another boat 210 ft. long which does 30 knots, "because the square roots of the respective lengths point out the proportionate speed of similarly proportioned vessels with proportionate power, and, consequently, the 210 ft. boat should have had a speed of 37 knots, with power in proportion to her tonnage. The Forban required about 4000-horse power, and so the 210 ft. boat would have required about 11,000-horse power to go at 37 knots speed. This is probably about double what the 210 ft. boat really had to dispose of."

But it is said that the bunkers of the Forban can hold only fifteen tons of coal, and half her displacement is due to the weight of her machinery. Fifteen tons of coal for 4000 horse-power represents short runs only, mere spurts, which might be of some service in a harbor police boat, and this only on rare occasions.

The correspondent above quoted, seems to think the kind of fuel had something to do with the speed attained. He says: "The British Admiralty compels contractors to use ordinary coal on trial-trips, and on low-speed consumption trials the fire-grates must not be materially reduced.

Not so in France; there the low-speed consumption trials, which determine the quantity of coal the bunkers must contain may be made with very largely reduced grates, and thereby of course, a considerable economy is attainable. Again, in France contractors are allowed to use a special class of fuel, viz., briquettes made of pulverized coal, out of which the earthy particles have been carefully washed, the coal being then mixed with certain tarry substances to make it cake in the process of hard pressing into briquettes. By such means it is possible to manufacture a fuel which far surpasses Welsh coal in power. It would be very interesting to try what speed could be got out of the Forban on a *three* hours run—not one hour—with ordinary Welsh coal, say Nixon's navigation. I fancy that 28 knots would be more likely than 31, for after a short time the bars would be nicely clinkered over when burning at the rate of probably one hundredweight per square foot of grate per hour. The total duration of the Forban's trial seems to have been about one and a-half hours only. In England a three hours' trial is exacted."

THE ENGINEERING INDEX—1896.

Current Leading Articles on Marine Engineering in the American, English and British Colonial Marine and Engineering Journals—See Introductory.

*5967. Coast and Lighthouse Illumination in France. C. S. Du Riche Preller (The first part, which deals with the recent great extension of the French coast-light system, and gives an illustrated statement of three different systems of classification of lights wifh their characteristics, indicates that the series will be of more than ordinary interest). Engng-May 1. Serial. 1st part. 2800 w.

*6009. The Rule of the Road at Sea (Editorial review of the report of a select committee of the British House of Commons appointed to consider the rule of the road at sea, which is regarded, with slight modifications, as the work of Sir Robert Reid. New rules have been formulated and approved by all the officers of the navy, after a conference at Washington of representatives of European powers and of the United States). Trans-May 1. 1500 w.

6034. A Great Lake Shipyard (Illustrated description of Messrs F. W. Wheeler and Co.'s extensive works at West Bay City. One of the finest vessel building plants in America). Sea-May 14. 900 w.

6096.—$1.25. Contract Trial of the United States Coast Line Battleship Massachusetts. C. H. Hayes (Full illustrated description of trial with extensive tabulated data). Jour Am Soc of Nav Engs-May. 8500 w.

6099.—$1.25. Forced Draft Trial of the U. S. S. Raleigh. C. R. Roelker (Full description of trial with diagram, speed curve and brief table of economic performance). Jour Am Soc of Nav Engs-May. 1400 w.

6100.—$1.25. Calculation of Horse-Power for Marine Propulsion. Thomas English (Read before the Inst. of Mech. Engs. A method whereby, with the ordinary appliances of a shipyard, results can be closely approximated, that could be obtained otherwise only by the use of the refined apparatus of a model tank. Illustrated with diagrams. Discussion). Jour Am Soc of Nav Engs-May. 2000 w.

6101.—$1.25. The Battle of the Yalu and Its Effect on the Construction of Warships. L. Ferrand (Abstract of a paper read before the Assn. Technique Maritime. In this paper the author reaches the conclusion that the true battleship of to-day can be a sort of monitor, only completely armored, low in the water, invulnerable against light artillery, powerfully armed and with speed sacrificed to protection and armament). Jour Am Soc of Nav Engs-May. 1700 w.

6159. The New Steamboat Adirondack (Illustrated detailed description). Am Ship-May 21. 500 w.

6167. The Long Island Sound Passenger Propeller Middletown, Built by the Neafie & Levy Ship and Engine Building Company of Philadelphia (Illustrated general description). Sea-May 21. 600 w.

*6236. Auxiliary Engines in Screw Steamers (Not only auxiliary engines but other marine engine accessories are discussed in this article). Eng, Lond-May 15. 3500 w.

*6242. The Bazin Disc Wheel Steamboat (Illustrated description). Eng, Lond-May 15. 1700 w.

*6325. The Problem of Speed. M. J. A. Normand (A paper read before the Maritime Technical Assn. An examination of the speed of torpedo vessels from a general point of view, and of the Forban in particular). Eng, Lond-May 22. 3000 w.

*6329. Mineral Oil in Marine Boilers (Editorial. A general review of the present status of practice with reference to the effect upon marine boilers of mineral oils used in the lubrication of engine cylinders). Engng-May 22. 3000 w.

*6330. The Russian Auxiliary Cruiser "Kherson" (Editorial comment upon the recent trial of the ship named and upon the performance of the Belleville boilers with which she is fitted). Engng-May 22. 2500 w.

*6449. The New Liverpool Landing Stage (Illustrated description of a floating stage at dock and a recent large extension of the same). Eng, Lond-May 29. 1500 w.

*6458. The Argentine Cruiser "Buenos Aires" (Illustrated detailed description). Engng-May 29. 900 w.

We supply copies of these articles. See introductory.

MECHANICAL ENGINEERING

Invention: Is It a Myth?

IN its issues of April 4 and 11 *Mining and Scientific Press* published a well-written article by Mr. W. H. Smyth, a mechanical expert and consulting engineer of Berkeley, Cal. This writer takes the ground that invention is an "indefinable requirement of the patent law." Many will agree that cases constantly arise wherein it is difficult, if not impossible, to determine whether a device is, or is not, an invention. It will also be admitted that, like many other words in common use, an exact definition of invention is perhaps impossible. This, however, does not prove that the word is not useful, or that its use is always or even generally misleading. For example, the two words "*animal*" and "*vegetable*" are in common use, and we could not dispense with them or some substitute for them; yet neither of these words is exactly defined, and there are cases of disagreement among experts as to the proper classification of some living things.

We have laws relating to the living and the dead. It is lawful to bury or to cremate the dead, but not the living. Practically no serious difficulty arises in the application of these laws; but the words "*life*" and "*death*" have never been exactly defined. Some things are alive; some things are dead; yet there is a borderland wherein the ablest biologists are unable to say with positiveness whether objects are, or are not, alive. The same practical difficulties arise in the interpretation of laws relating to the insane. Sanity and insanity have never been so exactly defined that we can always determine which of these terms ought to be applied to the state of mind observed in a particular case.

We might thus go on multiplying examples of indefinability; any one who does this thoughtfully and candidly will arise from his task surprised at the number of facts in all the relations of society, in the useful arts and in the sciences, that have never yet been exactly stated. Yet these facts must be stated in some way,—as perfectly as our faculties and knowledge permit,—because they are facts of constant experience. In the conclusions drawn from the statements made in these imperfect terms of expression, human judgment must supplement imperfect definition; and there is scarcely an hour of active life in which human judgment does not so act. Were it not so, experience would count for nothing, and the calling of the expert would cease to exist. It is the function of the expert to form better judgments and juster conclusions from imperfectly-stated facts than can be formed by those who have less knowledge and experience.

We may, therefore, freely admit that the word invention cannot be exactly defined; but we do not therefore admit that either the practical details of human life, or legal enactments, can on that account dispense with the term; and we dissent from the views expressed in the following quotation, although we readily admit that, in their support, Mr. Smyth has presented a very ingenious argument. After stating the statute provision that "the subject of a patent must be not only new and useful, but must also be an *invention*," the author says:

"It is my intention to show that, though the third requirement has always been in the statute, and its meaning substantially the same as the present interpretation, until recently it has practically been a dead letter.

"Further, that it is not by any means axiomatic that the third requirement is in any case *possible* of *fulfilment*, but, on the contrary, there are many cogent reasons for questioning whether 'invention,' like 'spontaneous generation,' is not a metaphysical myth.

"That, even if it be in fact a real quality, *it has never been defined;* nor is it of such

a character that its presence can in any case be determined beyond doubt. All authorities agree that 'questions of invention proceed upon fine and subtle metaphysical distinctions.'

"Strangest of all, the law and practice relating to patents, which provides this requirement involving metaphysical distinctions, also provides that decisions relative to these philosphical subtleties shall be rendered by mechanics, chemists, lawyers, etc., but never by expert metaphysicians.

"That, in effect, the patent office examiners and judges decide these questions arbitrarily. So the third requirement works injustice in all cases, but particularly in those involving the results of the highest and best form of mental industry, which the patent law was particularly designed to foster.

"And that it should be removed from the statute and the idea eliminated from the practice both in the patent office and courts."

With reference to the first of these propositions, it is not established by Mr. Smyth's argument that the requirement that the thing sought to be patented should be an invention has been until recently "a dead letter." Examiners in the patent office, if competent, have always taken this point into consideration, and have decided it one way or the other, as best they could, within the limitations of their knowledge and capacity for forming judgment.

Second, with reference to the possibility of determining the fact whether the subject of an application for letters patent is really an invention or not, we believe, in spite of what Mr. Smyth says in support of this view and the numerous examples of confusion of thought culled from decisions and writings,—some of them from high authorities,—and cited by him, that, in the great majority of cases, an average man, by the exercise of common sense and judgment, may determine whether the subject of a patent is, either in whole or in part, the result of invention or not. Similarly, the exercise of common sense and judgment would determine the question of sanity or insanity in the large majority of cases. Cases in which the average mind would be at fault are such as must be determined by experts; and patent examiners are, or should be, experts.

The third proposition has already been admitted as true; but, if all questions arising in civil or criminal law in which indefinable terms (that is to say, terms that can be defined only in a general way) are involved are to be decided only by a jury of "expert metaphysicians," there will soon be an end of much that is essential to the administration of justice in society. While society is made up of "mechanics, chemists, lawyers, etc.," it is not, and never will be, composed of expert metaphysicians; and, if it could be, it might well be doubted whether the administration of public business in ordinary affairs would be improved by the metaphysical mind.

Lastly, if the word "invention" should be "removed from the statute, and the idea eliminated from practice both in the patent office and the courts," we should be compelled to substitute for it some other equally indefinable, and therefore equally objectionable, term. Our language and thoughts would be strangely crippled, were the same thing to be done with all other words which cannot be exactly defined.

Odd Belt Lacings.

MR. B. F. FELLS, in *American Machinist* (May 28), presents some unusual schemes of belt-lacing, each of which, he says, has its advocates, although it is hard to conceive a reason for the existence of some of them. We have reproduced, on a somewhat smaller scale, the diagrams illustrating these odd lacings (some of which may certainly rank among mechanical curiosities), and Mr. Fells's description, also somewhat condensed, from which any one used to lacing belts will be able to produce each of the examples.

For making the lacing numbered 1 and 2, "about all the instruction that the ordinary man needs is that the holes be punched even and uniform, and that elastic lacing be used, the straight laces being run against the face of the pulleys. No. 1 is the front of this union, and No. 2 the back. The starting point for the lace

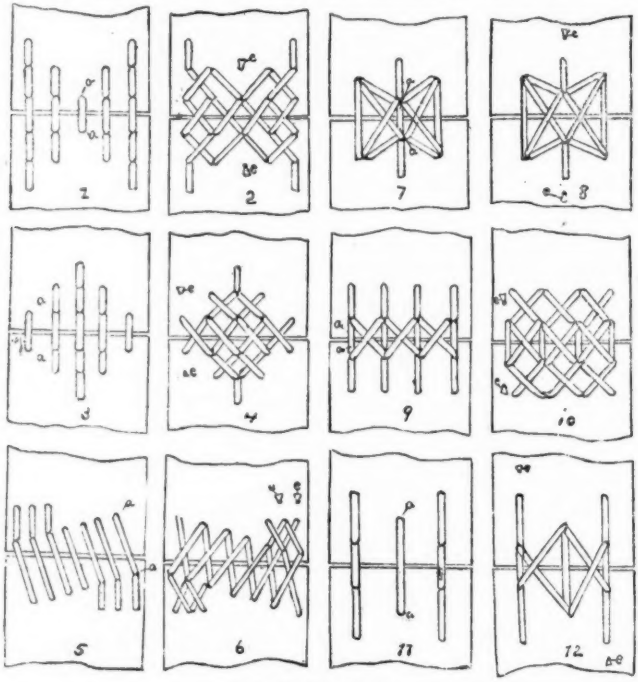
is at *a a*, and the sewing can be worked toward either side, coming back by crossing on the back, and going to the opposite side to return to the center again, where the union is completed and the ends of the lace brought out at *e e*." Mr. Fells regards this lacing as essentially weak, and we think that most mechanics will agree with him.

"Nos. 3 and 4 appear to be a substantial lacing for light work and general purposes, and easily and quickly made. The lacing can be readily done by commencing at *a a* in No. 3, and working to the opposite side in the manner shown on the back of No. 4, finishing at *e e*.

"Lacing No. 5 is quite odd. It is claimed that this will hold longer on quarter turns than some other kinds. It is made by beginning at *a a* with both ends of the lace, and lacing toward the other side, as indicated on the back of No. 6, ending at *e e*.

"No. 7 comes from a saw-mill man. It is loose and easily made, and adaptable for ordinary work. When belts that have considerable work to do are laced on this principle, a double sewing, or extra strong lacing, is required. Scratch two lines across each butt, about half an inch apart, and the inner line same distance from the edge of the butt. Then punch the holes at stated distances, and draw in the laces according to the diagram, beginning at *a a* and finishing at *e e*, No. 8, which is the back, on which the laces are crossed as on the face, owing to the double-lacing system.

"The maker of lacing Nos. 9 and 10 aims to distribute the strain of the lacings over as wide a surface as possible. To lace this, use a reliable lace and insert an end into holes *a a*, drawing the lacing through so that each end will be of the same length; then one of the ends of the lace down through the hole in front of last, up through opposite hole, and down through



ODD BELT LACINGS.

next hole beyond that, thus working the lace into the series of holes straight through, winding up at *e e*. Be sure the laps do not ride; do not draw the laces as tightly as you can; be careful not to get the laces twisted anywhere.

"A millwright sends in the sample Nos. 11 and 12. It is made by starting at *a a* in No. 11, and at *e e* in No. 12, which is the other side."

Apparatus for Blue Printing.

AN unsigned article in the *Practical Engineer* (May 15) says, with reference to the method of holding tracings over sensitized paper in blue printing, that it is a comparatively easy matter to obtain a good contact between a small negative on glass and the paper, but it is not so easy to deal with several square feet of tracing cloth and a corresponding area of sensitized paper. Notwithstanding this, the general tendency is to adopt large sheets of plate glass fitted into heavy wooden frames. A piece of thick felt is pressed against the paper by means of a flexible board, acted upon by some simple form of spring. This apparatus produces a good contact and sharp definition when carefully handled, but at the best it is clumsy, and the glass plate is always liable to fracture.

An improvement in this frame, and one which obviates the use of springs, is the addition of a rubber bag, which can be inflated after the tracing and photographic paper are in position, thus bringing them into close contact with the glass. This, however, adds to the first cost, and does not enhance the durability of the arrangement. With the not too careful usage of the office boy, the rubber deteriorates, and usually announces the fact by allowing the air to escape slowly during the process of exposure, thus buckling the tracing and spoiling the photograph. Instances are cited where tracings ten feet long have been satisfactorily photographed by means of two revolving rollers. The first roller may be about nine inches in diameter, covered with thick felt and a round of cartridge paper. Having mounted this roller upon a suitable axis, the tracing cloth, together with a continuous length of sensitized paper, is wound tightly upon the cylinder. The free end is attached to the second roller, upon which the cloth and paper are wound as the exposure is completed. With rapid paper, such as is now procurable, and a good sunlight, very good results may be obtained in this way with an exposure of about three minutes. Some simple way of revolving the rollers uniformly will readily suggest itself as suitable.

While this method is suitable for reproducing tracings of unlimited length, it is, of course, quite out of place in the ordinary routine of drawing-office work. An arrangement has been patented in Germany by which the air is exhausted by means of a pump from between a sheet of glass and the tracing cloth, in order to produce close contact, but this method is not favored. There is a simpler and inexpensive way of obtaining good results. Procure a well-flattened piece of ⅛-inch iron plate of the required width and length. Cover this with thick felt on one side by means of a cement or special glue. Cut off two stiff boards the same length as the iron plate, and batten them together side by side. The plate may then be laid upon these boards, and the tracing with the sensitized paper clamped to the felt side of the iron plate. Taking hold of the edges of the plate in the middle will cause it to deflect into a circular arc, drawing the creases out of the tracing cloth. Suitable notches cut in the boards to receive the lower edges of the plate will cause the latter to stand as an arch, with the tracing upon its upper surface. If the tracing is well clamped to begin with, a very slight curvature suffices to bring it into good contact with the photographic paper; this being so, the intensity of light all over the surface is fairly uniform. If necessary, the iron may be sprung in the reverse direction, to assist in taking out the creases and reducing the final curvature. Enough has been said to indicate the means of dispensing with expensive frames and large sheets of glass. With minor details conveniently arranged, the method described cannot fail to commend itself to any practical draughtsman.

Conductivity of Boiler Scale.—A Correction.

IN our June number two of the cuts (Figs. 3 and 4) illustrating experiments on conductivity of boiler scale were, by inadvertence, omitted. They are presented herewith, with description.

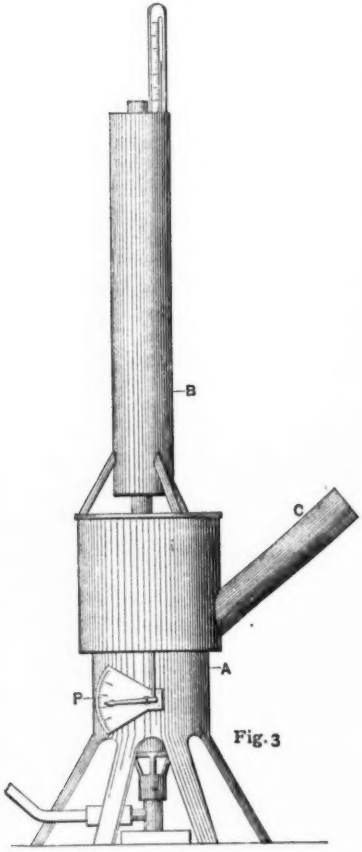


Fig. 3

Figs. 3 and 4 are views of an apparatus for testing the heating efficiency of clean and coated tubes. A small sheet-iron furnace A is heated by a small gas stove or Bunsen burner; on top of the furnace stands the vessel of water B. This vessel is about 1¾ inches in diameter and about 25 inches long. In the interior of this cylinder is a tube extending through the bottom of the cylinder into the top of the furnace and 1-32 of an inch thick and about 5-8 of an inch outside diameter, reaching from about one inch below the bottom end to a little above the top end of the cylinder. The ratio of the diameter to the length of this tube is about the same as that in ordinary boiler tubes.

There were several of these cylinders made; the dimensions and weight of the metallic parts were similar in every respect. Two of these vessels were left clean, but in one there was 3-32 of an inch of plaster of Paris coated on the tube, in the same way in which scale coats a boiler tube; in another vessel 1-4 of an inch of Portland cement was coated on the tube. The tendency of the heated gases from the flame will be to go through the tube in the vessel of water, but, as the capacity of this tube is not great enough to carry off all the gas, some must make its exit by coming down between the outside and inside casings of the furnace and flowing out through the chimney, C.

This chimney carries the surplus of heated products to such a distance from the vessel of water that there is no chance for the outside of the water vessel to act as a heating surface by receiving heat from rising hot gases. In the top of the furnace and directly under the tube is a pyrometer, P, which, though not indicating the degrees, serves to indicate changes in the temperature at the top of the furnace. This pyrometer is made of a small strip of brass riveted to a similar strip of iron, one end being secured to the side of the furnace, while the other is connected by a wire to a pointer that moves over a graduated scale. Unequal expansion of the brass and iron bends the riveted strips, the pointer indicating temperature. In the water at the top of the vessel is placed a thermometer.

Referring to the experiments described in our June number, *Power* says that "if relative conductivity determined the ratio of efficiency of heating surfaces, it would appear, then, that the water vessel with a clean tube will heat up in 4-26 of the time that it takes to heat the water vessel with its tube coated with 3-32 of an inch of plaster of Paris. That such ratios would

be incorrect is shown by the following: To heat from 64° to 205°, it took the water vessel with a clean tube 13 minutes and 10 seconds, and with the vessel in which the

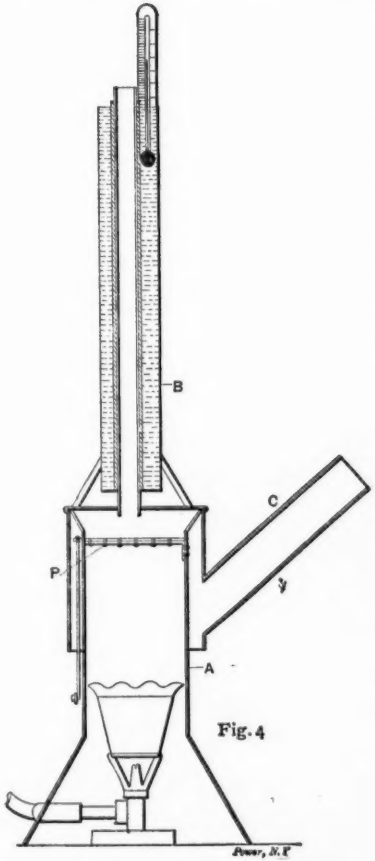


Fig. 4

tube was coated with plaster of Paris 3 32 thick there was no appreciable difference in the time required to heat the same quantity of water. The gas flame was the same in each of these tests, and the pyrometer showed that the temperature of the furnace had not varied."

The experiments were varied, but the indications were the same. It is admitted that the apparatus is rather a crude one, but there can be no mistake in the significance of the indications. When a conductor has sufficient conductivity to conduct from one side to the opposite side all the heat applied to the receiving side, no increase of its conductivity can make it conduct any more heat than is applied to the receiving side.

Annealing Steel.

THE AMERICAN ARTISAN, having stated that for annealing steel there is no better material than charcoal, is courteously reminded by *The Engineer* (New York) that some kinds of steel cannot be thus annealed. The editor of *The Engineer* was formerly interested in the sale of steel for manufacturing purposes, and, in discussing the point thus raised, he favors his readers with an interesting and instructive leaf from his own experience. He says: "In 1865 we sold a quantity—forty tons—of decarbonized gun-steel to a Rhode Island firm, for making rifle-barrels. This steel was all cut to short lengths, and was useless for any other purpose. It was annealed by the buyers, and, when they came to drill it, it was found impossible to touch it with a tool. The steel was rejected, and held subject to our order. This was a serious matter, for at that time steel was worth something like ten cents gold. We were sent to investigate the method of annealing, and found that it had been treated in the manner described above. This seemed to us the cause of the trouble, for, as we argued, annealing decarbonized steel in charcoal for a matter of three days (heating and cooling) turned it into cemented steel, and it had the appearance of it when broken; a bar of it, struck across an anvil smartly, broke like glass, with a crystalline fracture. We ordered all the steel reannealed in spent gas-house lime, used in the purifiers, we believe, of which large quantities can be had for nothing. This proved entirely satisfactory, and the steel worked perfectly under every tool. Spent gas-house lime is the best vehicle for annealing steel we ever found or heard of; the steel is more like lead than steel, and its hardening qualities and durability are unimpaired. Twenty-four hours—even twelve hours—are sufficient to anneal the steel in lime."

THE ENGINEERING INDEX—1896.

Current Leading Articles on Mechanical Engineering in the American, English and British Colonial Engineering Journals—See Introductory.

The Machine Shop.

6061. Utility and Advancement of Green, Dry Sand, and Loam Molding. Thomas D. West (Read at the first National Convention of Foundrymen. On the different methods, and a knowledge of general principles being necessary to enable the molder to determine which method was best for any piece of work). Ir Tr Rev-May 14. 1700 w.

6065. Foundry Cranes. A. E. Outerbridge, Jr. (Fundamental practical considerations common to all cranes are discussed and essential qualifications are set forth). Ir Age-May 14. 1600 w.

6066. Compressed Air in the Foundry. Cutis W. Shields (The many uses to which compressed air can be advantageously applied in the foundry are set forth in this paper). Ir Age-May 14. 2400 w.

†6074. Modern Foundry Practice in Connection with Manufacture. John Morris (Machine moulding, and mixtures of iron found advantageous in practice are the topics chiefly touched upon in this paper). Engineers' Year Book-Univ of Minn. 2200 w.

†6078. Notes on Machine Designing John H. Barr (In this paper the engineering elements and the commercial elements that must be taken into account in designing machinery, are considered together and the necessary compromises between them). Engineers' Year Book-Univ of Minn. 1400 w.

†6088. Descriptive Geometry and Working Drawings. W. H. Kirchner (The importance of the study in constructive mechanics, and the different quadrant methods of projection, are the chief topics of discussion). Engineers' Year Book-Univ of Minn. 1400 w.

6161. Coiled Springs. E. T. Adams (General discussion of the practicability of a table of average strength and deflection that will be of service to practical men, with a diagram). Am Mach-May 21. 1300 w.

6162. A Fixture for Grinding Profile Cutters. A. L. de Leeuw (Illustrated description). Am Mach-May 21. 1200 w.

6163. Slipping Clutch for Electrically-Driven Punches and Shears (Illustrated description of a clutch which is claimed to overcome difficulties experienced with clutches previously employed). Am Mach-May 21. 900 w.

6166. Testing Lubricating Oils. W. E. Crane (Cheap device for this purpose described and illustrated). Am Mach-May 21. 500 w.

*6233. Frames for Blue Printing (Useful practical hints). Prac Eng-May 15. 800 w.

6275. Odd Belt Lacings B. F. Fells (Twelve unusual varieties of lacing are illustrated and the method of making each described). Am Mach-May 28. 500 w.

6278. The Use of the Slide Rule. F. A. Halsey (The first part deals with general principles). Am Mach-May 28. Serial. 1st part. 1800 w.

6279. Inspection Tests. F B. F. Spalding (An argument emphasizing the necessity of thorough inspection of work at the right stages, as an element of success in manufacturing). Am Mach-May 28. 2200 w.

6420. Twist Drill Making and Other Operations at New Bedford. M. (Illustrated description of plant, tools and processes). Am Mach-June 4. 4400 w.

Steam Engineering.

*5972. Circulation in Water-Tube Boilers. A. C. Elliott (An attempt to formulate mathematically the principles of boiler circulation). (Engng-May 1. Serial. 1st part. 2200 w.

*5976. The Production of Steam and Power. W. Stagg (Boilers of different types classified in order of efficiency, and the subjects of steam production and power production, with conditions of economy are discussed). Gas Wld-May 2. 3000 w.

6098.—$1.25. Temperature—Entropy Diagrams for Steam and Water. Louis M. Nulton (The graphic method applied to the calorimetric study of an engine, and the exchanges of heat taking place between the fluid and the internal walls of the cylinder). Jour Am Soc of Nav Engs-May. 3500 w.

6109. Loop Losses in Compound Engines. Charles M. Jones (A demonstration that looping between the cylinders of a multi-expansion engine not only involves a loss of power, but that the loop area is not a criterion of this loss. The true measure of the loss is also explained). Elec Engng-May. 1100 w.

6153. Steam Boilers: Their Equipment and Management. Albert A. Cary (Read before the National Electric Light Assn. Part first begins the discussion of what style of boiler is best adapted to the work). Elec Rev-May 20. Serial. 1st part. 1500 w.

6160. Piston Valves. W. H. Booth (First part describes and illustrates a continuous bodied piston valve and a provision for preserving the circularity). Am Mach-May 21. 1000 w.

*6238. Wegener's Powdered Fuel Boiler Furnace and Apparatus (Brief description and tabulated data of a test of the apparatus by Mr. Bryan Donkin). Eng, Lond-May 15. 1000 w.

6349. A Theory of the Injector. Myron G. Stolp (The action of the injector is found analogous to that of the condensing steam-pump. An interesting and instructive article). Mas St Fitter-May. 2000 w.

6361. Greene-Wheelock Vertical Compound Engine at the Atlantic Avenue Station of the Edison Illuminating Co., of Boston (Illustrated detailed description). Power-June. 2000 w.

6362. Steam Plant of the American Surety

Company's Building, Broadway, New York (Illustrated detailed description). Power-June. 1500 w.

6387. Special Forms of Engine Foundations. E. A. Merrill (Illustrated description of an engine foundation specially adapted for situations where the building foundation is carried to bed rock from which it is necessary to isolate the engine foundation). Am Elect'n-May. 600 w.

†6424. The Worthington Cooling Tower for the Continuous Use of Condensing Water. John H. Cooper (Illustrated description and discussion of advantages). Jour Fr Inst-June. 2500 w.

*6460. Compound Mill Engines (Illustrated detailed description). Engng-May 29 1300 w.

Miscellany.

*5968. The Panhard-Levassor Road Motor (Illustrated detailed description). Engng-May 1. 2600 w.

*5969. The Latrobe Steel Works (An interesting illustrated general description). Engng-May 1. 1600 w.

*5970. Lock-Nuts and Nut Locking Devices. E. H. G. Brewster (Paper read before the Civil and Mechanical Engineers' Society. The first part is a general discussion of the large number of patented lock-nut devices which have been placed before the public. The requirements (not few) of a perfect nut locking device and mention of attempts made to meet these requirements). Engng-May 1. Serial. 1st part. 3000 w.

*5973. Automatic Breech Mechanism for Quick-Firing Guns (Illustrated detailed description of a very ingenious device). Engng-May 1. 1400 w.

†6085. Railway Mechanical Engineering. H. Wade Hibbard (A plea for greater attention to locomotive mechanical engineering in our technical schools). Engineers' Year Book-Univ of Minn. 4300 w.

6093. Water Power in New England. James Francis (Abstract from a paper entitled "Power" read before the Washburn Engineering Society of the Worcester Polytechnic Institute. A masterly review of practice with turbine water wheels, emphasizing the fact that the effect of draft tubes is a subject that needs further research. Comparison of cost of steam and water is made, and increase in the use of turbines for power stations transmitting power by electricity is predicted). Eng Rec-May 16. 2200 w.

6097 —$1.25. Formulæ for the Strength of Seams, Stays and Braces for Cylindrical Boilers. A. B. Canaga (These formulæ are based upon the propositions that the thickness and lap of the shell sheets, the diameter and pitch of the rivets, should be so proportioned that the shell shall be on the point of tearing asunder between the rivets, just as the plate in front of the rivets and the rivets themselves, are about to give way by crushing. And that the tightness of the seam will be insured when the elements of the seams are proportioned for greatest strength to resist bursting pressure. The seams usual in marine cylindrical boilers are the ones considered. The subject is illustrated by diagrams). Jour Am Soc of Nav Engs-May. 2800 w.

6157. Compressed Air as Used for Power Purposes. Frederick C. Weber (Lecture delivered before the Engineering Society of Columbia College. The first part deals with the principal uses, production, compression and sources of loss). Compressed Air-May. 2000 w.

6209. Molding Machines and Their Field. Harris Tabor (General treatment of the subject and statement of advantages and limitations). Ir Tr Rev-May 21. 2500 w.

6211. Hydraulic Rotative Engines. Arthur Rigg (Paper read before the Soc. of Engs. The development of the modern rotative hydraulic engine is traced from the time of Bramah, up to date). Ind & Ir-May 8. Serial. 1st part. 4500 w.

*6260. Notes on Conveying-Belts and Their Use. Thomas Robins, Jr. (Describes experiments with various compositions of rubber for conveying belts, and then discusses the different ways of supporting such belts, with what the author regards as the best way). Col Guard-May 15. 3000 w.

*6294 The McKenna Process of Renewing Steel Rails. Robert W. Hunt (Lecture delivered before the students of Sibley College. The writer reviews the history of rails, and the changes that affected their service, with the methods used to overcome the difficulties, with explanation of the named process). Sibley Jour of Engng-May. 3800 w.

*6295. Test of Gas Engine Plant. Charles E. Barry (A description of the plant of the Danbury & Bethel Car and Electric Co. of Danbury, Conn., with account of test). Sibley Jour of Engng-May. 3000 w.

*6296. Test of a Refrigerating Plant. E. L. Spencer and A. W. Wyckoff (The machine tested is of the De La Vergne make and had been in operation less than one year. The plant is described, and test reported). Sib Jour of Engng-May. 1200 w.

*6297. Car and Line Tests on the Buffalo and Niagara Falls Electric Railway. H. O. Pond and H. P. Curtiss (Abstract from thesis in Mechanical Engineering. The test was divided into friction test, traction test, acceleration and electrical tests of car, etc). Sib Jour of Engng-May. 1000 w.

*6344 Recent Improvements in Coal-Handling Machinery. John D. Isaacs (Read before the Technical Society of the Pacific Coast. Illustrated description of improved apparatus for handling coal. Discussion follows). Jour of Assn of Engng Socs-April. 4000 w.

*6450. What Is An Invention? (An able editorial criticism of a widely copied paper by W. H. Smyth, originally printed in the *Mining and Scientific Press*, entitled "Invention: the Indefinable Requirement of the Patent Law"). Eng, Lond-May 29. 1500 w.

6455. Natural Gas and Its Use as a Fuel. Bert M. Seymour (Present practice in applying natural gas to heating furnaces in the arts and to generation of steam). Sta Eng-June. 1000 w.

*6456. Compressed Air Tramways (Describes the Serpollet system for the propulsion of cars on tramways). Engng-May 29. 3200 w.

MINING & METALLURGY

A Metallurgic Revolution.

DR. THEO. B. COMSTOCK, writing for the *Engineering and Mining Journal*, uses this title for a brief article upon another aspect of the changed conditions which are so ably reviewed by Dr. Chance in the June and July numbers of THE ENGINEERING MAGAZINE, in his papers on "Recent Improvements in Gold Milling."

A few years ago, says Dr. Comstock, "once in a while a light demand would occur for rich concentrates, and very rarely would come a call for a carload or two of pyritous ores; but the free handling of auriferous sulphurets was out of the question at profitable rates. The smelters, which absorbed the whole product shipped from the mines, were but poorly provided with roasting facilities. This condition has now been so completely revolutionized that vast areas in Colorado, California, Arizona, and New Mexico are to-day marketing auriferous sulphids and other ores in quantity from mines hitherto abandoned and from below the water level in mines hitherto unprofitable within the water zone.

"In the vicinity of Prescott, Ariz., the pecuniary factor, as shown by results of shipments five years ago and now, has altered as much as $26 per ton in favor of the seller, in some instances. A part of this, to be sure, is the effect of reduced freight traffic, but a very large proportion is due to the lowering of the treatment charge for smelting and the credit given for iron in the ore in excess on a neutral basis.

"There are people to-day who object to investing in mines carrying pyritous ores simply because they are not informed regarding the metallurgic revolution which has given these materials a respectable standing in our ore markets. These constitute the great bulk of the product of central Arizona, as well as of other regions in the West, and many of the deposits are remarkably rich in gold. I do not think we are handling them all with adequate skill when we cling, as many do, to the old stamp-mill process, with fine concentration, although much of this practice may be justifiable with the surface ores, which carry free gold. Sooner or later the employment of coarse concentration, with chlorination or a similar process, must come to be the accepted doctrine for much of our local product, as in portions of California, although pyritic smelting may well play an important *rôle* in many instances.

"Those who imagine or pretend that the changed conditions are more favorable to the success of local custom reduction works, near the mines, are reasoning from false premises, or giving evidence of ignorance of metallurgic principles,—I mean business principles, practical business requirements. Copper matting, or, possibly, copper smelting, for ores carrying practically no gold or silver, might be judiciously operated at selected points, but rarely, as a custom plant, to as great advantage as in the hands of a mine-owner. If the revolution, now but begun, has any particular effect upon the success of local works, it must be constantly to diminish their profits in proportion as it gives advantages to the large corporations at the centers of trade, the labor, money, ore, and bullion markets, where costs are minimized and facilities vastly increased, to say nothing of the vantage gained by choice of ores and fluxes, with the means of enforcing low rates of freight and other concessions."

"No revolution in metallurgy can make a mine out of a tunnel or shaft, however much it may decrease the proportion of cost to income. But there are several ways in which a dollar may be justly claimed to have greater earning power than formerly, on account of this particular revolution. For one thing, it has caused unwonted competition among manufacturers of machinery. As a consequence, we have more and better and cheaper mining tools and appliances than before. Powder, used more economically, is lower in price, steel is better and less costly, skilled labor

is more abundant and more skilled, and somewhat reduced in price. Provisions and other supplies are furnished in most mining camps much more reasonably than formerly. Ore is hauled by skilful teamsters at less cost, and in many other items the expense of mining and reducing ores has been very materially lessened within the last five years. When to all this is added the marked increase in marketable adaptability of ores of different grades and qualities, formerly outclassed or unprofitable, and the many abandoned mines which are now paying dividends from discarded dumps alone, we have a picture of the mining industry more tempting to investors than at any previous period; and careful investigation will show that it is yielding to business-like investment more returns than any other form of enterprise open to capital."

Dr. Comstock's remarks with regard to the small demand for the construction of "local custom reduction works" are interesting, in view of the rather indiscriminate appeal which has recently been made to capitalists to invest their funds in enterprises of this character.

Decadence of the British Iron Trade.

THE COLLIERY GUARDIAN prints a portion of a letter from Mr. B. H. Thwaite, C. E., from which the following extract is taken:

"To any one who has watched the growth of continental manufacturing industrial enterprise, the serious meaning of the following statistics in Mr. Jacks's paper, read before the recent meeting of the British Iron Trade Association, will not have come as a revelation:

THE WORLD'S PRODUCTION OF PIG IRON.

	1871.	1882.	1893.
Great Britain..	6,627,000	8,493,287	6,229,841
Germany.....	1,278,000	3,469,719	4,700,000
Other countries.	3,878,000	9,358,693	11,709,502

PROPORTION OF THE WORLD'S OUTPUT SUPPLIED BY GREAT BRITAIN.

1871.	1882.	1893.
Per cent.	Per cent.	Per cent.
50	40	29

"The British output is practically stationary, whereas Germany has increased her output by 300 per cent., and the combined output of other countries has increased from 1871 to 1893 by 300 per cent.

"Serious as the signs of our industrial decadence undoubtedly are, they are the more irritating because our natural advantages are unrivalled, as the following sequence of interrogatories proves: (1) Where can we find a country possessing sites for industrial establishments, and at the same time so geographically situated as to be center of the two worlds? (2) Where is there a country with such a line of seaboard and with such harbors in proximity to deposits of the raw materials required to manufacture merchantable iron and steel? (3) In what country do we find in such extraordinarily appropriate association all the raw materials necessary for the production of merchantable iron? Every true answer to these questions will be the same. We have unique natural facilities, and this natural birthright in a race where we have so many paces to our good should compel us to try to utilize these advantages to the full. We obtain our ores, our coals, and our fluxes cheaper than any of our competitors, but, once the labor element is associated with their conversion into merchantable iron or steel, our deficiencies commence to assert themselves. English workmen were once the labor aristocrats of the world, and the title English-made was a character of the highest excellence. This was in the era of individual labor; English workmen had pride in their work, because their individual efforts and skill were preserved. The new order of industrial collectivism has meant the more or less complete destruction of individualism, and with it the pride of the individual Englishman in his work. The continental workman has been trained by years of comparative serfdom to value the money return for his labor, and he is able to make a mark or shilling purchase in the necessities of life twice that which an English workman can obtain for the same expenditure. So that he is paid on an average but 60 per cent. for the same output of work (labor-cost per ton of output); nevertheless, he manages to exist perhaps as comfortably and as well as the English-

man. This difference of 40 per cent. in labor-costs and in the greater continuity of industrial peace (labor strikes are of rare occurrence) tends to destroy the intrinsic natural advantages possessed by the English employer in low cost of raw materials, and makes it possible for the German and Belgian manufacturer (handicapped as he is by nature both in the possession of metalliferous and the carbonaceous agents) to successfully compete with us in foreign markets. The cost of carriage of raw and manufactured materials again gives the continental competitor the advantage over us. The governments of France, Germany, and Belgium have never been so unwise as to allow the rail-carriage proprietors to destroy the water-carriage means of communication. This is what the British government has done. The canals have been suspended from operation by neglect, and, although there are some 3,000 miles of canal-ways in this country, probably only one-half their length is navigable. The railway companies bought them up, and have allowed them to fall into disuse. The fact is, the one big industrial question that is coming rapidly to the front is: Shall British iron, steel, and other heavy manufacturing industries be sacrificed on the altar of railway monopoly?"

It is risking little to say that Mr. Thwaite's conception of the cause of the loss of British supremacy will hardly appear adequate to a large number at least of his readers, and the answers, on this side of the water, to his triumphant questions will not be as unhesitatingly favorable to his argument as he assumes.

It is amusing, in view of the figures of the American iron trade, to notice how completely Mr. Thwaite ignores it as an individual factor, and sinks it in the miscellaneous total of "other countries." As a matter of fact the pig-iron production of the United States was, for 1871, 1,730,800 tons; for 1882, 4,698,790 tons; and, for 1893, 7,239,206 tons.

Accepting Mr. Thwaite's figures for the total output of the world (they agree fairly well with those of *The Mineral Industry* for 1893), we get the following

PROPORTION OF THE WORLD'S OUTPUT SUPPLIED BY AMERICA.

1871.	1882.	1893.
15%	22%	32%

The proportionate influence of natural advantages and artificial conditions in producing this increase is too deep an inquiry to institute here. No doubt our protectionist essayists and statesmen would insist that the infant industry had been most healthily and successfully stimulated by careful nursing.

The important question, after all, might be how much each country produced outside of its home consumption; but, if Mr. Thwaite is anxious to locate England's lost supremacy in total output, he might cast his eyes this way, and discover one of the "other countries" which, since 1871, has increased its output more than three hundred per cent., and in 1893 produced some fifteen per cent. more pig iron than Great Britain herself.

Production of Metal Bars by Extrusion.

MR. ALEXANDER DICK'S "squeezing or squirting patents," as they are termed in graphic, if somewhat homely, language, seem likely to form the basis of a new industrial process, the contemplation of which excites mixed feelings of respect for its importance, admiration for its simplicity, and wonder that no one has done it before.

As a matter of fact, the principle had long been applied, as everyone knows, in the manufacture of lead pipe and lead wire. The enlargement of the application needed only that adjustment of conditions to requirements which anyone might have made, but which it apparently remained for Mr. Dick actually to effect.

Lead flows under pressure, because it is plastic; to cause other metals to behave in a similar way required only that they should be brought into a similar state of plasticity through the influence on their molecular structure of the simple agency of heat.

Mr. Dick's process consists in placing the red-hot metal in a cylindrical pressure chamber, fitted at one end with a die. Upon application of pressure at the other

end, the metal is forced through the die in a rod of section determined by the shape of the die-opening.

As frequently happens in the perfection of inventions, the greatest difficulties seem to have been encountered in determining the details. The most important was the construction of the containing cylinder, which, in the first experiments, was made of solid steel, bored out to the required diameter. It was found, however, that, even if previously heated in a coke fire, the strains on the cylinder walls from unequal heating and cooling, superadded to those caused by the heavy pressure on the contained metal, soon developed cracks which made the apparatus useless.

Success was ultimately attained by using a built-up cylinder, formed of a thin internal liner jacketed with successive alternating metal shells and interlayers of non-conducting material.

The size of the cylinder, and other conditions, vary, of course, with the size and nature of the charge to be pressed. In making small rods, the die may have several openings, forming as many rods at each operation. This practice is, indeed, actually installed.

So far, it is understood from Mr. Perry F. Nursey's paper before the Iron and Steel Institute, the process has been commercially installed at two or three English and continental works, and is being applied to "Delta metal, brass, aluminum, aluminum bronze, and other alloys and metals." He considers it "not outside the bounds of possibility" that it may be adapted to handling iron and steel.

It is not surprising to learn further that the process greatly improves the physical properties of metals subjected to it. "Some tests made at Woolwich Arsenal with Delta metal bars produced by extrusion show a tensile strength of 48 tons per square inch, with 32.5 per cent. elongation in two inches, against 38 tons per square inch tensile strength and 20 per cent. elongation of rolled bars of the same metal."

Mr. Dick seems to have developed an interesting and practical metallurgical improvement, with large possibilities of extension.

The Available Stores of Anthracite.

PROF. WILLIAMS'S article in this issue on the utilization of anthracite culm affords a startling revelation of the enormous and reckless waste which has attended mining operations in the past, and which has but recently begun to excite any uneasiness or meet any check.

Nature's stores appear so lavish, and man's appreciation of his huge consuming power is so inadequate, that the lesson of economy is never learned, except through experience, and, when learned, is immediately forgotten, or, at least, never applied by obvious analogy to a parallel series of conditions.

Probably the swiftest and sharpest, as well as most recent, example is natural gas. Seldom has the development based on discovery and expectation been so large, the waste so reckless, or the inevitable result so prompt.

The close relation to the fuel question has awakened a new solicitude regarding the sufficiency of other fuel supplies, and this lends a heightened interest to the elaborate data on the subject of anthracite coal prepared by the *Bond Record*, which have been in course of publication for some months and are enriched with maps and special diagrams. The author of the series is Mr. William Griffith, of Scranton.

In view of the great care with which the work seems to have been done, especial importance will attach to the estimate of the total anthracite tonnage supply of the future, which is placed at 5,073,786,750 tons. The figures, however, are "intentionally conservative." They are concerned with shipment coal only, and hence exclude local consumption. In the northern field all beds are ignored which will not yield 3 feet of clean coal, and in other fields all which will not yield 2½ feet. Culm piles and pillars are also excluded, and the figures omit the Bernice coal-field in Sullivan county, estimated to contain ten to fifteen million tons of marketable coal.

It is interesting to compare these figures with former estimates quoted in the articles. Joseph S. Harris, in a *Forum* ar-

ticle (April, 1892), placed the total anthracite usable as fuel, including that in culm-piles and pillars, at 5,960,000,000 tons; the report of the Pennsylvania Coal Waste Commission for 1893, including thinner beds than those considered by Mr. Griffith, makes a "liberal estimate" of 6,898,000,000 tons.

Such figures mean little to most persons, and the *Bond Record* adds:

"It will perhaps help the reader to a better comprehension of the figures of our table to say that the future tonnage of the anthracite region, if prepared for market, would completely fill an ordinary city street, 60 feet in width, to a depth of 60 feet, or say to the tops of the fifth story windows, for a distance of 8,800 miles. On the basis of the shipments of 1895 we are exhausting this supply at the rate of about 81 miles per year, and, according to the record of the past 25 years, the consumption is increasing at the rate of over two additional miles per year. As previously stated, this does not include the tonnage from culm piles and other sources, from which a considerable supply will doubtless be obtained in the future; for, as certain sections cease to yield, further efforts will doubtless be made to re-work the abandoned mines. Considerable tonnage will thus be obtained, as well as from the thinner veins not included in our estimate."

"According to the summarized estimate, 109 years is the life of the anthracite industry, on the basis of shipments made in 1895. If we follow Mr. Joseph S. Harris, president of the Philadelphia & Reading Railroad Co., in assuming 60,000,000 tons as the limit of annual shipments, the supply would last about 84 years, and, at the average annual rate of increase from 1870 to 1895 (1,200,000 tons per annum), this limit would be reached in about ten years,—*i. e.*, in 1906."

It is not surprising, in view of modern tendencies, to learn that an output comparatively so limited has been subjected to efforts at control, but the completeness and the apportionment of the result will perhaps be surprising,—at least, interesting.

Here are the figures of shipment, allotment, and tonnage reserve.

	Percent. of shipment, 1895	Percent. allotment 1896.	Per cent. future supply controlled.
Del., Lacka. & Western R.R. Co.	13.16	13.35	6.55
Del. & Hudson Canal Co.	9.34	9.60	2.29
Erie & Wyoming Valley R. R. Co	3.75	4.00	1.82
Erie R. R. Co.	3.91	4.00	.77
N. Y., Ont. & Western Ry. Co.	3.06	3.10	.28
N. Y., Susque. & West. R. R. Co.	3.02	3.20	.54
Del., Susq. & Schuylk. R. R. Co.	4.11	3.50	1.38
Pennsylvania R. R. Co.	10 59	11.40	6.24
Central R. R. of New Jersey	11.51	11.70	17.30
Lehigh Valley R. R Co.	15 81	15.65	16.87
Phila. & Reading R. R. Co.	21.47	20.50	42.25
Uncontrolled tonnage.			3.71
Total [see diagram on page 501]			100.00

"From this we see that the corporations named control, either directly, or indirectly through their sub-companies, 96.29 per cent. of the available tonnage of the future, and in about the following manner:

They own, by actual purchase or its equivalent	90.93%
They control by long-term contracts, say about	3.36%
They control by short-term contracts of various kinds, say	2.00%
	96.29%
Uncontrolled,—*i. e.*, remaining in private hands	3 71%
Total	100.00%

"The above figures show how completely the anthracite industry is under the control of the above corporations, and it must be evident that they are in a position to form a powerful combination, trust, or what you will, if they can only unite upon a policy and adhere to it."

The *Bond Record* naturally regards the question largely from the investors' standpoint of possible dividends.

To the general public, the exhaustion of the future resources will appear the larger question: the clear view of the end of one important fuel supply suggests grave dangers.

The answer may be found in some wonderful advance in economy, not only in mining, but in using coal, such as would result from the perfection of a process for direct production of electricity from the latent energy of carbon. Such a

promise is held forth by Jacques's patent, discussed elsewhere in this number. Again, the answer may be as unexpected as the discovery of mineral oil, just about the time when the world was growing anxious over the approaching extinction of the sperm whale. It would be strange, indeed, if the "coal combine" should find its importance waning as rapidly as did that of the New Bedford whaler.

THE ENGINEERING INDEX—1896.

Current Leading Articles on Mining and Metallurgy in the American, English and British Colonial Min ing and Engineering Journals—See Introductory.

Metallurgy.

*5942. Recent Improvements in Gold Milling. H. M. Chance (Showing how gold-milling processes have been lowered in cost and increased in efficiency). Eng Mag–June. 3900 w.

*5959. Remarks on Iron and Steel Rolling Mills. John T. Brassington (Paper read before the West of Scotland Iron and Steel Institute. A general view of rolling mills used for iron and steel for the purpose of showing the progress that has been made in size and output in the last 20 or 30 years). Ir & St Trs Jour–April 25. Serial. 1st part. 1300 w.

5986. Furnace Construction and Fine Ores. Guy R. Johnson (A letter to the editor referring to Mr. F. E. Bachman's paper on the deposition of carbon in the Mesabi ores, etc., and making suggestions aiming to overcome difficulties mentioned in the named paper). Ir Tr Rev–May 7. 500 w.

*5988. Nickel Steel. William Beardmore (Read before the Inst. of Engineers and Shipbuilders in Scotland. Results of investigations with a view to proving that what can be done with carbon steel can be more advantageously accomplished with nickel steel). Ind & Ir–May 1. 1800 w.

*6011. The Manufacture of Wrought Iron (Historical account of the industry from the earliest records to the present). Ir & Coal Trs Rev–May 1. 3500 w.

*6012. Modern Blast-Furnace Practice and the Pig-Iron Manufacture of Different Countries. Presidential address of E. Windsor Richards before the Inst. of Mech. Engs. (An interesting record of the competitive circumstances of the leading iron-making countries of the world in reference to this branch of the iron trade, and supplying facts of value to all who are concerned in this industry). Ir & Coal Trs Rev–May 1. Serial. 1st part. 6500 w.

*6013. The Recovery of Ammonia in Coke Manufacture. From *Stahl und Eisen* (Investigations of noted scientists and their conclusions). Ir & Coal Trs Rev–May 1. 1000 w.

6062. Physical Tests and Chemistry of Cast Iron. W. J. Keep (Read at the first National Convention of Foundrymen. Directions for testing with 16 tables and 3 charts. The tables are taken from the records of the Committee on Tests and Methods of Testing of A. S. M. E.) Ir Tr Rev–May 14. 4800 w.

†6077. Some Experiments with Brom-Cyan. H. C. Cutter (Experiments made with the new solvent for gold showing that in some cases brom-cyan solution gives better results than simple potassium cyanide). Engineers' Year Book–Univ of Minn. 800 w.

*6105. The Production of Metallic Bars of Any Section by Extrusion at High Temperatures. Ill. Perry F. Nursey (Paper read before the Iron and Steel Inst. Descriptive of an ingenious metallurgical process, the invention of Mr. Alexander Dick, and considered to be of far-reaching importance). Eng, Lond–May 8. 2400 w.

*6135 The Ford and Moncur Hot-Blast Stove. Benjamin James Hall (Paper read before the Iron and Steel Inst. A description of the Ford and Moncur patent, which has given excellent results for 12 years). Col Guard–May 8. 1800 w.

6141. Comparative Tests of Nickel Iron Alloys. David H. Browne (The writer proposes to show, in practical units and figures which are readily comprehended and remembered, the effect which nickel has on the strength of wrought iron, cast iron and steel). Eng & Min Jour–May 16. 1200 w.

6142. The Volatilization of Silver in Chloridizing-Roasting. L. D. Godshall (A reply to the criticism of the late Mr. Stetefeldt). Eng & Min Jour–May 16. 2000 w.

6206. Quantitative Estimation of Tin. Cecil J. Brooks (A brief record of experiments made to ascertain the cause of the low results which are often obtained in the determination of tin). Eng & Min Jour–May 23. 600 w.

*6223. English and American Rolling Mills (Abstracts of two papers read before the British Inst. of Civ. Engs. I. American and English Methods of Manufacturing Steel Plates, was by Jeremiah Head. II. Four American Rolling Mills, by Samuel T. Wellman. Mr. Head's paper was a comparison of methods. The second paper describes four mills, typical of modern American practice). Engng–May 15. 1800 w.

*6249. Mond Producer Gas Applied to the Manufacture of Steel. John H. Darby (Read before the Iron and Steel Inst. As Dr. Ludwig Mond has explained his process for the manufacture of the gas, in an address some time ago, the writer confines himself to the improvements and the application of the gas to the manufacture of steel). Min Jour–May 16. Serial. 1st part. 2200 w.

We supply copies of these articles. See introductory.

*6256. The Chemical Composition and the Strength of Malleable Iron. A. Ledebur, in *Stahl und Eisen* (Review of two works by Baron Jüptner von Jonstorff on his investigations of this subject, with reference to the experiments of Mr. Webster of America). Ir & Coal Trs Rev–May 15. 1500 w.

*6257. The Iron Industry of Birmingham and Bessemer, U. S. A. Jeremiah Head (The facts and opinions of the writer, as presented, are the result of two visits to Alabama, and of information since obtained). Ir & Coal Trs Rev–May 15 4200 w.

*6281. The Introduction of Standard Methods of Analysis. Baron Hanns Jüptner von Jonstorff (Abstract read before the British Iron and Steel Inst. A discussion of the subject, its difficulties and the important questions to be considered. A valuable paper of special interest to chemists in iron and steel works. It was followed by a discussion). Ir & St Trs Jour–May 16. 5800 w.

*6282. On the Rate of Diffusion of Carbon in Iron. Prof. Roberts-Austen (Abstract of paper read before the British Iron and Steel Inst. Facts of importance in relation to the question of the passage of sulphur and sulphides into the center of an ingot, especially the passage of solid carbon into solid iron). Ir & St Trs Jour–May 16. 2000 w.

*6283. Note on Mr. Howe's Researches on the Hardening of Steel. F. Osmond (Read before the British Iron and Steel Inst., with discussion. A comparative examination of manganese, nickel, and active carbon to see how the critical points and the essential physical properties may be correlated). Ir & St Trs Jour–May 16. 7200 w.

6290.—$1.50. The Condition of Steel in Bridge Pins. A. C. Cunningham (An account of the making of bridge pins and the necessity for special testing, with four tables of tests, with specifications submitted as being likely to procure as good bridge pins as can be had in common practice). Am Soc of Civ Engs–May. 2000 w.

*6346 The Diffusion of Metals. W. C. Roberts-Austen (A brief abstract of the "Bakerian Lecture" of the Royal Society, showing that diffusion can be measured in both molten and solid metals). Nature–May 21. 2500 w.

6369. A Metallurgic Revolution. Theo. B. Comstock (Mainly dealing with the increase in value of auriferous sulphurets, due to improved methods, &c). Eng & Min Jour–May 30. 1200 w.

6385. Cupolas and Cupola Practice up to Date. Edward Kirk (Prepared for the National Convention of Foundrymen, Phila. A review of the best practice in cupola melting, with much information on the subject). Ir Tr Rev–May 28. 2000 w.

*6478. A Sketch of a Modern Blast Furnace Stack. A. P. Gaines (Describes and discusses briefly the blast furnace stack only). Eng Assn of the South–April. 3400 w.

6485. Aluminum the Metal of the Future. From "The Wonders of Modern Mechanism" (In what its value lies and its uses, with a review of its properties). Prog of the Wld–June. 1500 w.

*6491. A Rare Metal. T. L. Phipson (The value of thorium and its light giving property—showing how a new industry has arisen from its discovery). Knowledge–June. 1500 w.

6492. Cost of Basic Open-Hearth Plants. From *Tin and Terne* (Refers only to such a basic open-hearth plant as would be appropriate as an adjunct to a tin plate plant. Estimate is given in which the writer endeavors to allow fully for all expenses). Ir Tr Rev–June 4. 1400 w.

Mining.

*5962. The Ballarat Gold Field (Account of the working of the mines, the researches seeming to favor the opinion that gold shoots will be found to have extended to greater depths than humanity will be able to follow). Aust Min Stand–March 19. Serial. 1st part. 1200 w.

*5987. Transmission of Power by Compressed Air at the North Star Mine, California. P. R. Robert (Read before the Inst. of Min. & Met. The first part is descriptive of the plant and its working). Min Jour–May 2. Serial. 1st part. 2800 w.

*5990. Sinking a New Shaft at the Colliery of the West Bohemian Company, Near Pilsen. K. Anton Weithofer (Description of general arrangements, sinking, masonry and ventilating of the "Bayer" shaft). Col Guard–May 1. 2200 w.

*5991. Honigmann's Method of Boring Mine Shafts. W. Schulz (Abstract of paper in *Glückauf*. A sinking tower is let down into a tubbed shaft, and the water pumped out, and mixed with loam or clay, is allowed to flow back into the shaft, the loam addition consolidating the shaft sides). Col Guard–May 1. 2000 w.

6023. Ontario as a Mining Country. A. P. Coleman (An enumeration of the minerals, metals, &c., found in Ontario, and their value, stating that petroleum gives the greatest aggregate return. The mines are many of them worthy the attention of capitalists). Can Eng–May. 4000 w.

*5992. A Theory in Mine Ventilation (An account of interesting experiences in mine ventilation in which certain anomalies in air flow, contrary to currently accepted theory, manifested themselves, and which have compelled the author to think it is time that colliery managers and engineers recognized that there are other factors in efficient ventilation than mere volume, and that the ventilating pressure shown by the water-gauge is not a record of the subtle gains, losses, restitutions and differential influences of the pressure *en route*). Col Guard–May 1. 2400 w.

†6079. Elements of Methods of Metal Mining, Based upon Lake Superior Practice. Ill. F. W. Denton (A description of the method or system of mining, the work of the removal of the deposit, and the considerations which should influence the establishment of a method of min-

ing). Engineers' Year Book–Univ of Minn. 6200 w.

*6133. Regulations as to Fiery Mines in the Loire Coalfield (Substance of the government regulations as to ventilation, lighting, and the use of explosives for fiery mines in the French department of La Loire, issued last Sept. on behalf of the Prefect). Col Guard–May 8. 2800 w.

*6139. Notes on Sinking Two Shafts by Poetsch's Freezing Process, at Ounaing, near Valenciennes, France. H. F. Olds (A paper read before the first students' meeting of the Inst. of Mining and Metallurgy. Descriptive of two shafts sunk by congelation by the Auzin Mining Co). Min Jour–May 9. 1000 w.

6143. Texas Coal-Fields. R. S. Weitzell (Brief description of the bituminous coal-fields). Eng & Min Jour–May 16. 500 w.

†6144. Outline Scheme for Mine Surveying. Edward B. Durham (Considers the location of stations, running underground traverse, shaft surveys, calculations and plots). Sch of Mines Quar–April. 4500 w.

*6250. Ancient Mining: With Especial Reference to that Carried on in Great Britain. A. Cooper Key (The author has endeavored to consolidate and condense all the facts he could obtain in regard to ancient mining, and to present them as clearly as was possible in the limit of a short paper. The first part treats of Egyptian surface-working and mining, mines in Asia, and Phœnician mining). Min Jour–May 16. 1200 w.

*6251. The Placer Gold Fields of Ecuador (An editorial account of the region with the prediction that the country is destined to add considerably to the world's output of gold). Min Jour–May 16. 1200 w.

†6252. The Coal Fields of Labuan (A short description of this island in the China seas and its coal field, of interest because of the important part it would play in any naval operations which Great Britain may undertake in the East). Ind Engng–April 18. 900 w.

*6259. Safety in Colliery Winding. C. M. Percy (Read at the meeting of the Manchester Geological Society. The writer presents, what in his opinion is a really good equipment, thus making accidents in mines, with colliery winding appliances, very nearly impossible). Col Guard–May 15. 3000 w.

*6261. New Arrangement for Putting Down Mine Shafts (From a communication by Friedrich Gerber to *Gluckauf*. A contrivance, illustrated by engravings, is described which was designed to secure the greatest possible continuity in sinking shafts, and bringing up to the surface the stuff excavated, with any water encountered; rapid, easy and safe loading and unloading of the above, as well as of materials hung on to the skip, no trans-shipment being required; and high duty). Col Guard–May 15. 1700 w.

*6262. Probable Continuity of the Shropshire, South Staffordshire, and Forest of Wyre Coalfields. W. J. Clarke (Read before the Dudley and Midland Geological and Scientific Soc. at Coalbrookdale. Information concerning this region, explaining difficulties that do not seem likely to be overcome, hence the probabilities are not promising). Col Guard–May 15. 2500 w.

6289.—$1.50. A Water Power and Compressed Air Transmission Plant for the North Star Mining Company, Grass Valley, Cal. Ill. Arthur De Wint Foote (A concise description of the whole plant is first submitted, followed by the detailed presentation of its several parts, and finally the results obtained after careful tests during three months of actual working). Am Soc of Civ Engs–May. 6500 w.

6306. The Cyanide Process at the Mercur Mine. B. E. Janes (Extracts from a paper read before the students of the University of California. The first notable success with the cyanide process in America was made at the Mercur mine. The peculiar nature of the ore seems to be adapted to the cyanide process). Min & Sci Pr–May 23. 2400 w.

*6334. Annals of Coal Mining and the Coal Trade. Robert L. Galloway (The first part is a review of the history previous to 1066 A. D.). Col Guar–May 22. Serial. 1st part. 4400 w.

*6335. Constitution of the Southern Portion of the Valenciennes Coalfield. M. Chapuy (From a communication to the *Annales des Mines*. Fresh information as to measures in the south of the coalfield and a comparison of acquired facts with the various hypotheses put forward). Col Guard–May 22. 4600 w.

*6336. Mining in the Brown Coal District of North-west Bohemia and the Pilsen (Hard) Coal Field. Remy: *Zeitschrift für Berg, Hutten-und Salinenwesen* (Describes the beds, character of coal, development of the industry, workings, &c). Col Guard–May 22. 3000 w.

6347. The Wyoming Petroleum Oil Fields. Wilbur C. Knight (An account of the early history and development, oil districts, nature of the oils, geology, &c). Am Mfr & Ir Wld–May 29. 1600 w.

*6386. The Coal Deposits of the North-West Territories of Canada. W. Henry (Describing particularly the lignite deposit of the Souris Valley). Min Jour–May 23. 2500 w.

6400. Exploring with the Govt. Diamond Drill. Thomas W. Gibson (The important aid to mining rendered by the diamond drill, a description of the instrument and practice in operating, are the subject of part first). Can Min Jour–May. Serial. 1st part. 2200 w.

*6428. The Oquirrh Mountains or the Mercur Mining District, Utah (An epitome of the Geological Survey's report of the region by Messrs. Emmons and Spurr, with notes and comments by Prof. Arthur Lakes). Col Eng–June. 5400 w.

*6429. The Vulcan Explosion. David Griffiths (A description of the mine and the conditions existing therein. The work of rescue and an investigation of the probable cause of the disaster). Col Eng–June. 6000 w.

*6473. The Dayton Mine Explosion. F. P. Clute (A brief description of the mine and existing conditions, and of the disastrous explosion

of Dec. 20, 1895, with the cause). Eng Assn of the South-April. 4500 w.

*6474. Handling Coal by Gravity at Whitwell, Tenn. Tyler Calhoun (A description of the mines and manner of handling the coal. From 800 to 1000 tons per day is the output). Eng Assn of the South-April. 3400 w.

*6476. Coal Handling Plant at Pikeville, Tenn. J. J. Ormsbee (Illustrated description of a plant designed to handle the coal carefully and clean it thoroughly). Eng Assn of the South-April. 1300 w.

*6479. Gold Mining in Georgia. B. M. Hall (This brief paper is intended to call attention to some sources of information, and to point out a few peculiarities of the industry). Eng Assn of the South-April. 1600 w.

*6481. The Sapphire and Ruby Mines of South-Eastern Siam. From the London *Times* (Historical account of discovery of the mines, with interesting information, description, etc). Min Jour-May 30. 3000 w.

*6482. Notes on the South Wales Coalfield. M. E. (Description of measures, method of working, ventilation, hauling, pumping and coking). Col Guard-May 29. 1200 w.

*6483. Report of Her Majesty's Inspectors of Explosives for 1895 (The twentieth annual report. Reviews the modifications of the law since the Act came into operation, the growth of the trade, and the additions to the list of authorized explosives). Col Guard-May 29. 1800 w.

6495. The Cedar Valley Quarry. Samuel Calvin (Illustrated description of a quarry in Cedar Co., Ia., with its machinery and manner of working). Eng & Min Jour-June 6. 1400 w.

Miscellany.

*5963. Terrible Colliery Catastrophe in New Zealand (Brief account of accident in the Brunner coal mine in the Greymouth district of New Zealand in which 60 miners were killed. Illustration of the scene of the disaster). Aust Min Stand-April 2. 1000 w.

*6010. The Iron Trade of Great Britain Half-a-Century Ago. From Vol. 109 *Quarterly Review* (Historical review of the iron trade, tracing the progress and causes that have influenced it). Ir & Coal Trs Rev-May 1. 2500 w.

6036. Some Notes on the Occurrence of Uraninite in Colorado. Richard Pearce (Read before the Colorado Scientific Society in Denver. History of its first discovery in Aug. 1871, and of the amount and value realized). Min Ind & Rev-May 7. 900 w.

†6086. Ore Deposits in Minnesota. Arthur H. Elftman (A brief sketch of the present status of development of iron, manganese, gold and silver, nickel and cobalt, and copper). Engineers' Year Book-Univ of Minn. 900 w.

*6134. On the Treatment of New Zealand Magnetic Iron-sands. E. Metcalf Smith (Paper read before the Iron and Steel Inst. A description of the extensive deposit, analysis and treatment). Col Guard-May 8. 800 w.

6140. The Mineral Production of California in 1895 (Facts taken from the statement of the California State Mining Bureau with editorial comments). Eng & Min Jour-May 16. 1000 w.

6149. Early Use of Anthracite Coal. William Griffith in the *Bond Record* (An interesting account of the discovery and use of anthracite, dating back to 1762). Bul of Am Ir & St Assn-May 20. 1100 w.

6207. Mineral Resources of the Judith Mountains, Montana. Walter Harvey Weed (Geology of the region, with some account of the mines that have been producers, and give promise of bright future. The distance from railroads makes the working of low grade ores impossible, and a large amount of ore already developed is practically lying idle for want of proper treatment). Eng & Min Jour-May 23. 1700 w.

6348. "The Invention of the Bessemer Process." Jos. D. Weeks (An answer to the criticisms on the address of the writer in which he claimed that the honor of the invention belonged to William Kelly). Am Mfr & Ir Wld-May 29. 2500 w.

6364. William Kelly's Own Account of His Invention of the Pneumatic Process (An Account prepared by Mr. Kelly in 1884 for incorporation in the "History of the Manufacture of Iron in All Ages"). Bul of the Am Ir & St Assn-June 1. 1500 w.

6401. The Treatment of Timber for Use in Mines. Robert Martin (Read before the Mining Inst. of Scotland. Treatment to render the wood durable and incombustible). Can Min Jour-May. 2500 w.

6402. Gold and Silver Ores of the Slocan, B. C. J. C. Gwillam in *Can. Record of Science* (Brief account of the geology, with description of the minerals and metals found). Can Min Jour-May. 1000 w.

*6430. The Metamorphism of Coal—How It Occurs and What Causes It. H. Bolton (The conversion of bituminous coal into anthracite and graphite, and the conversion of carbonaceous matter into diamond). Col Eng-June. 5500 w.

*6431. Classification of Bituminous Coals. Baird Halberstadt (What constitutes good steam, gas, smithing and coking coals). Col Eng-June. 2100 w.

*6432. Coke Oven Construction. R. M. Atwater (Its effect on coke, with special reference to Semet-Solvay ovens. The object of the paper is to offer methods of coking the Pittsburg coal, which will enlarge the boundaries of the standard coking coal to all the Pittsburg coal fields that bear coal of standard chemical composition. Read before the Soc. of Engs. of Western Penna). Col Eng-June. 2500 w.

*6438. The Gold Fields of Alaska. Robert Stein (Largely descriptive of the country and means of access to the gold fields). Rev of Rev-June. 3000 w.

6494. The Opening Up of Our Big Goldfield. Dan DeQuille (The condition of gold mining in this country, and the value of the mines, with reference to foreign mines). Eng & Min Jour-June 6. 2400 w.

We supply copies of these articles. See introductory.

MUNICIPAL ENGINEERING

City Sanitation.

In a lecture delivered at the Sanitary Institute, an abstract of which is printed in *The Sanitary Record* (London, May 8), Mr. Charles Mason, member of the Institute of Civil Engineers, and surveyor, St. Martin-in-the-Fields, places asphalt at the head of all paving materials for city streets as regards sanitation. Therefore, all courts and alleys, where the ordinary street traffic need not be considered, should be paved with asphalt. Whatever is of an unsanitary nature (or liable to become so on exposure to atmospheric influences), falling upon the surface of an asphalt pavement, remains on the surface, and may be easily and thoroughly removed by washing with water.

The trapping of street gulleys—or "gutters," as we call them in American cities—is also advocated. With the exception of their outlets, they should be made water-tight. Upon the imperviousness of surfaces in streets, courts, and alleys the maintenance of perfect sanitary conditions much depends. A good form of gulley is the stone-ware, trapped, coffee-pot gulley, which is easily cleaned out, and which prevents the entrance of mud into sewers. A new form of gulley known as the "Crosta" gulley is commended, and has been largely adopted in London and other English towns. It has a double trap, and protects the sewers from the entrance of anything deleterious.

As to collection and disposal of refuse, method, first and always, should be the watchword. Every detail should be brought under an inexorable rule. Those districts of London that have a regular routine system—a system that cannot be departed from under any excuse—are the cleanest and best kept.

In London there are practically two systems for the removal of snow,—*viz.*, (1) by sweeping, and carting away; (2) by sprinkling salt, and washing the resultant liquid off the road. Clean snow can be tipped into the river or sewers; it is, however, seldom that the latter course is adopted, as only the main sewers have sufficient volume and velocity to take away the snow as quickly as it is deposited in the manholes. The use of salt is often a necessary evil, and should be resorted to only when circumstances render it almost impossible to deal with snow by carting. Everything in connection with a fall of snow requires a perfect system in management, with all in readiness for use at a moment's notice.

Street-watering is a necessity in the summer months as a means of keeping down the dust, which accumulates in greater or less degree upon all classes of pavement. In many English seaside towns salt water is used for street-watering, which is in itself far more effective than fresh water. It lasts for a much longer time, one load of sea water being equal to three loads of fresh. An objection has been raised that sea water is detrimental to the road surfaces, but it has not been proved to be founded on facts, and may be considered as groundless. That sea water lasts three times as long as fresh water is a strong argument in its favor.

Instead of making large receptacles for refuse and removing it at long intervals, modern sanitation takes the opposite course. Small receptacles and frequent removal is now the approved practice. Disposal of human excreta by what is known as the conservancy system the lecturer regards as adapted only to small towns. The removal of these matters by water has proved safer, more convenient, and more economical in large cities.

Touching cremation of garbage, the objection that it destroys valuable material that might otherwise be saved is answered by the statement that the heat produced, properly applied to generation of power, more than offsets the alleged loss. The system of carting all refuse to the nearest

waste ground, or filling up disused brick yards in the neighborhood of towns, is condemned as directly opposed to all ideas of modern sanitation. It is to be regretted that many towns still carry on this rough-and-ready way of getting rid of their refuse. The disposal of refuse by cremation has for some considerable time occupied the attention of sanitary authorities, and the system of erecting refuse-destructors is now being adopted by a great many municipalities.

Contamination of Wells.

AT a recent meeting of the American Water Works Association, Dr. J. N. Hurty secretary of the Indiana State board of health, in reading a paper entitled "The Water Supply of Indianapolis" (reported in *Paving and Municipal Engineering* (June), said that well-water in that vicinity had been badly contaminated from surface drainage, even to the second water level. "Two weeks after a great fire, where millions of gallons of water were thrown upon burning wholesale houses, wells drawing their supply from the second water level tasted of sugar, salt bacon, and stale fish, located a distance of several hundred feet from where the fire occurred. The public water-supply of Indianapolis, obtained from White river and nine artesian wells, had been notably free from impurities until quite recently, when analyses had shown pollution with fecal bacteria. This had been traced to the dumping of offal by vault-cleaners in the river, nine miles above Indianapolis, which was at once stopped."

A representative of the water company maintained that the impurities named by Dr. Hurty were not the menace to health that might be supposed. In his remarks he said:

"Fecal bacteria are found under some circumstances in practically all surface-waters. E. O. Jordan has found in spring water, which was beyond any suspicion of contamination, bacteria which in form, size, growth on gelatine, potato, etc., were indistinguishable from bacillus coli communis. Dr. Theobald Smith says: 'I am not inclined to doubt the presence of an occasional individual of b. c. c. in any water which reaches the surface of the earth, owing to the presence of the latter in all natural manures. Burri suggests that the detection of fecal bacteria in a large quantity of water may lead to the condemnation of really good water. The wide distribution of the colon group has led some writers to regard b. c. c. of little value as a symptom of fecal contamination.' At present the tendency seems to be in the other direction, and more attention is being paid to processes designed to reveal its presence. Schardinger is inclined to look upon the presence of gas-producing forms of all kinds in water as indicative of pollution. This is true, if by pollution we mean filth of any kind, for the movement towards pollution, especially of surface-water, seems to begin with the appearance of gas-producers, which steadily increase in numbers with the amount of pollution."

In investigations of water-pollution some samples from sources practically unpolluted showed no fecal bacteria. Other samples from apparently as good sources contained four or five such bacteria in the cubic centimeter. These bacteria get into surface water from animal feces, and from these sources, unless the quantity is large, no danger is to be apprehended. When the sources of the bacteria are human fecal matter, there may be grave danger. It is, therefore, unsafe to condemn surface water on account of the presence of fecal bacteria alone. Their quantity and the sources from which they probably come must also be considered.

Asphalt Pavements Laid upon Natural Soil.

THE practicability or impracticability of using asphalt for paving directly upon compacted soil, and without the usual foundation, on streets where the traffic is light, will, according to *The Investor* (Los Angeles, Cal.), soon be demonstrated by an experiment in Los Angeles. In discussing this method *The Investor* states some of the local effects upon property in that city resulting from the use of granite pavements instead of the clean and noiseless asphalt. It says:

"Advocates—mostly interested ones, of course—have from time to time appeared, each recommending his favorite material. Granite blocks, vitrified brick, porphyry, macadam, asphaltum, bituminous rock, eucalyptus cedar, and other wooden blocks, have each found strong advocates. In some cases the argument of cheapness has prevailed, to the after-regret of property owners, who have learned that the first cost is sometimes the least before they get through with paving. One pays for a pavement in more ways than one, and the payment is not by any means finished when the contractor has received his due. At the time that the streets of Los Angeles were first paved, the ring wanted to introduce granite blocks, and it secured, by the way of compromise, the contract for a certain portion of the business streets. In those very portions, without any exception, the rents have since declined over fifty per cent., and the property owners are organizing to have the blocks sunk two inches deep and covered with asphaltum. In the streets where the noiseless, clean pavement was laid, business has gained and rents have risen.

"While property owners in Los Angeles can well afford to lay an expensive pavement with concrete foundation upon the business streets, and feel that they have made an excellent investment, in localities where the frontage is much less valuable the endeavor is to obtain a cheaper substitute.

"At Riverside, a mile and a quarter of city streets are being paved with the well-known Alcatraz asphalt, which is laid to the depth of two inches upon the natural soil previously excavated and well-rolled The simplicity and cheapness of this method of street-paving are admirable, but could only be successful in those places where the soil is firm and hard. In San Diego a similar plan was tried four years ago, when ten blocks were paved in this manner. It has proved so successful that ten blocks more are now to be paved in the same way.

"No pavement, no matter what surface-material is used, can be better than its foundation,—a dictum that applies to concrete as well as earth. It is not so much the traffic that injures a pavement as it is inexperience in laying, and neglect, and want of cleanliness after it is down, the blind permissions given to tear it up for sewer and other pipe connections, and the ignorance and indifference attending its repair."

It is admitted that such a pavement can succeed only in special situations; but, wherever practicable, the saving of the cost of a concrete foundation is an item worth considering. Also, in tearing up pavements for pipe work, the cost of opening the pavement and of repairing it again will be less. Municipalities will do well, however, to go slowly in the adoption of this method of paving. Preliminary experiments with small surfaces should be made, to indicate whether the soil is sufficiently compactible to warrant laying asphalt directly upon it.

Comparative Cost of Filtration with and without Alum.

IN a paper read before the American Water Works Association, and printed in *Paving and Municipal Engineering* for June, Mr. Allen Hazen, while asserting that results are of the first importance in filtration for water-supply, and that cost is secondary, still considers the question of cost as one that cannot be disregarded. In concluding his paper, he said:

"The reversal of the order of these two points is a continual and ever-recurring source of disaster the world over. A process which fails to accomplish its ends is dear at any price, and a process capable of yielding an abundance of pure and wholesome water is of such inestimable value as to be cheap, whatever it costs; and I am confident that our American cities are abundantly able to pay for the best process of filtration obtainable, whatever that may be, and that they should, and eventually will, insist upon having it, regardless of any trifling savings which may be made by the installation of inadequate or imperfect filters."

Mr. Hazen stated that the efficiency of mechanical filtration at high rates, as also of sand filtration, depends upon the addi-

tion of alum to the water before filtration. But the use of alum is practically inadmissible with some of the soft waters of New England and other parts of the country, which contain very small quantities of alkaline carbonates; and he considers that the cost of alum is another and serious objection to its use.

"It has sometimes been said that the quantity of alum to be used need not exceed a grain per gallon, and even lower limits have often been mentioned. As a matter of fact, however, I believe that it must be admitted that, both with waters highly charged with peaty matters, and with the muddy waters of our great rivers, a complete and satisfactory clarification and purification cannot be obtained with any such quantity of alum, and that from two to five grains per gallon are often required to secure a thoroughly satisfactory effluent at the rates of filtration commonly employed with such filters. A grain of alum in itself is certainly a very small quantity, but, when applied to each of many million gallons of water, the aggregate is very large, and at 2 cents per pound for alum, the cost of this quantity is $2.85 per million gallons,—a sum largely in excess of the entire cost of operating sand filters. When, in addition, the labor, power, and other expenses connected with the operation of mechanical filters are taken into account, it seems reasonably certain that the cost of operation per million gallons is far above the cost of operating sand filters.

"A great deal of ingenuity has been bestowed upon the construction of incubators to take the place of hens in chicken-raising. The advantages of the novel procedure are many and obvious, but I have yet to hear of an apparatus that will lay eggs, or that will hatch them in less than the three weeks that all well-bred hens require. Of course, I would not intimate for a moment that the safe rate of filtration is limited with a corresponding precision, but I do wish to say that we should have very adequate grounds for doing so before breaking away from abundant and conclusive European practice in the pursuit of methods for shortening and simplifying the process, particularly in view of the enormous importance of the thoroughness of the work, and the fact that inadequate results are not always promptly recognized, and great damage may be done before the injury is realized."

The Automatic Gas Sales Meters.

WHEN first introduced, these machines were supposed to be—and are even now called—automatic; but, according to *The Gas Engineer* (May 11), this class of consumer requires an enormous amount of looking after, and, although the meter is a splendid invention, it cannot, at present, be considered "automatic." The machinery for closing the valve after the consumption of so small a quantity as twenty-five feet appears still to be fraught with difficulties. There is nothing for it but the most rigid system of periodical inspection. A recent case is cited where a man went into an empty house. Not knowing whether there was gas or not, he placed a penny into the meter and lit the gas; thinking that, when his pennyworth of gas was consumed, the supply would be automatically turned off, he left the house, and also left the gas burning. This was careless. Many days after, an employee of the gas company passed, and to his surprise saw a light burning in the empty house. It is added that the very small margin allowed in the increased price charged will not warrant such losses.

THE ENGINEERING INDEX—1896.

Current Leading Articles on Municipal Engineering in the American, English, and British Colonial Engineering and Municipal Journals—See Introductory.

Gas Supply.

5964. The Determination of a Light Unit. D. W. Murphy (Description of construction and use of an instrument devised by Prof. Lummer and Dr. Kurlbaum of the Physikalisebe Reichsanstalt, called the balometer and based upon the light emitted by one square centimeter of platinum kept at constant temperature. This seems an important innovation). Am Gas Lgt Jour–May 11. 2500 w.

5965. Diagrammatic Outlining of Gas Sales on Fuel and Illuminating Account (The method

We supply copies of these articles. See introductory

is illustrated by actual diagrams with explanatory text). Am Gas Lgt Jour–May 11. 300 w.

*5977. Some Experiences in Incandescent Lighting for Workshops, Sheds and Open Spaces. E. C. Riley (A short sketch of experiences in actual practice, adapting the Welsbach incandescent burners to requirements indicated in the title). Gas Wld–May 2. 2800 w.

*5978. How to Minimize Bad Debts. J. H. Penney (A discussion of sound business methods as applied to the business of manufacturing gas). Gas Wld–May 2. 3400 w.

6070. Commercial Value of Acetylene Gas as an Illuminant. T. A. Ferguson (Extract from a paper read before the National Electric Light Assn. An estimate of the minimum cost of electric lighting, leads the author to the conclusion that acetylene is not likely to prove a successful rival either to the incandescent gas light, or the electric light). Eng News–May 14. 2000 w.

*6092. Elusive Leakages from Main and Service Pipes. H. Tobey (Paper read before the North of England Assn. of Gas Managers. Experience with gas leaking into a sewer pipe. Discussion). Gas Wld–May 9. 5400 w.

6224. A Discussion of Certain Recent Data on the Cost of Acetylene and Calcium Carbide. W. H. Birchmore (Review of the report of experts sent by *Progressive Age* to investigate the calcium carbide, in which appears to be implied a disingenuous intention on the part of those in interest toward the public, and the accuracy of the figures given by the committee are questioned as not representing average conditions). Am Gas Lgt Jour–May 25. 3400 w.

*6225. Nine Years Ago and Now. William Foulis (Inaugural address on the recent progress in the manufacture of gas). Gas Wld–May 16. 5500 w.

*6226. Notes on Residuals. Charles Hunt (Paper read before the Incorporated Inst. of Gas Engineers. Economies possible in the treatment of residuals and other interesting details concerning these products, with discussion). Gas Wld–May 16. 6400 w.

*6227. On the Efficiency of the London Argand at Different Rates of Gas Consumption, with Special Reference to its Use as a Gas Testing Burner. Lewis T. Wright (Paper read before the Incorporated Inst. of Gas Engineers. Disputes the statement, in King's Treatise on Coal Gas, that the maximum illumination of this burner is reached under all circumstances just as the lamp is about to smoke, and submits the action of this burner to a critical study. With discussion). Gas Wld–May 16. 7800 w.

6353. A Few Words on Naphthaline. John Gimper (Dissents from the opinion that the formation of naphthaline is caused by temperature changes, and attributes it to the presence of water. Discussion). Am Gas Lgt Jour–June 1. 2000 w.

6357. The Future of the Gas Business of America. M. S. Greenough (A retrospect and a forecast). Am Gas Lgt Jour–June 1. 8300 w.

6358. Wrinkle Department at the Meeting of the Western Gas Association (Results of experiences, opinions, methods, and other practical information make up this paper, which is edited by a member of the association). Am Gas Lgt Jour–June 1. 6800 w.

6359. Practical Use of Acetylene. W. W. Goodwin (The employment of acetylene as an enricher is viewed favorably and the conclusions of Prof. Vivian B. Lewes on the subject are adversely criticised). Am Gas Lgt Jour–June 1. 2700 w.

6360. One Year's Experience with Gas in the Metropolis of Texas. W. A. McGoldrick (An interesting record with discussion). Am Gas Lgt Jour–June 1. 2700 w.

*6378. Incandescent Gas Lighting. V. B. Lewes (An exceedingly interesting and valuable paper largely historical, but also ably treating the scientific and practical sides of the subject. With discussion). Gas Wld–May 23. 12500 w.

*6379. The Measurement of Gas in Relation to Temperature. George Livesey (The effect of temperature upon gas metering and the need of some way of ascertaining how much a record of measurement may be vitiated thereby is the burden of the paper). Gas Wld–May 23. 1600 w.

*6380. The Application of the Expansion of Fluids to the Correct Measurement of Gas Passing Through Meters. W. W. Fiddes (Deals with the unaccounted for gas, resulting from temperature effects upon the action of meters. With discussion). Gas Wld–May 23. 6400 w.

Sewerage.

*5989. Sewage Purification (An exceedingly well prepared article dealing broadly with the subject and presenting illustrations of the important English sewage filtration works at Huddersfield and Melton Mowbray). Ind & Ir –May 1. 3000 w.

6069. Tables and Diagrams for Facilitating the Computation of Estimates for Sewerage Work. S. M. Swaab (A set of tables and diagrams whose object is to facilitate computation of estimates for sewerage work, with inset of diagrams). Eng News–May 14. 700 w.

6203. The Sewerage of Melbourne (Interesting historical and descriptive account). Eng Rec–May 23. 3500 w.

6415. Cement Pipes with Metal Skeleton (Illustrated description, translated from *La Nature*). Brick–June. 300 w.

6440. The Sewage Disposal Works of Natick Mass. (Illustrated detailed description). Eng News–June 4. 900 w.

Streets and Pavements.

*6411. Kinds of Pavement in American Cities (Tabulated statement of the kinds and extent of each kind of pavement used in some sixty-five cities in the United States and Canada). Pav & Mun Engng–June. 200 w.

6416. Brick Paving Statistics. George W. Kummer (Answer to a circular of inquiry. First part contains answers from Akron, O., Albany N. Y., and Altoona, Pa). Brick–June. 1500 w

We supply copies of these articles. See introductory.

6419. The Improvement of the North River Water Front, New York City (Illustrated detailed description). Sci Am–June 6. 1300 w.

Water Supply.

5975. St. Catharines, Ont., Water Works (Illustrated general description) Fire & Water–May 9. Serial. 1st part. 1500 w.

†6087. Foundations for a Power House. George J. Loy (Describes means and methods employed for meeting unexpected difficulties in placing the foundations, arising from inability to keep the excavation clear of water. A final resort to sheet piling enabled the excavation to be completed and the foundation was built upon bearing piles). Engineers' Year Book–Univ of Minn. 1000 w.

6091. Norfolk, Va., Water Works (Illustrated general description). Fire & Water–May 16. Serial. 1st part. 700 w.

6094. The Chain of Rocks Pumping Station, St. Louis (Illustrated detailed description). Eng Rec–May 16. 1700 w.

*6136. The Thirlmere Works for the Water Supply of Manchester. G. H. Hill (Read before the Inst. of Civ. Engs. Abstract. General description). Col Guard–May 8. 1000 w.

*6137. The Vyrnwy Works for the Water Supply of Liverpool. G. F. Deacon (Abstract of paper read before the Inst. of Civ. Engs. Descriptive). Col Guard–May 8. 800 w.

6182. The Jewell Mechanical Water Filter Plant at Wilkesbarre, Pa. (Very full illustrated description of this system of filtration, and of the plant). Eng News–May 21. 4400 w.

6183. How Meter Records Are Kept at Battle Creek, Mich. (Description of method and its merits, with a sample meter table). Eng News–May 21. 400 w.

6184. Extension of a Covered Water-Works Reservoir at Vienna (Trans. from the "Journal of the Austrian Soc. of Engs. & Archs. Interesting illustrated description). Eng News–May 21. 500 w.

6185. The Water Supply System of Ogden, Utah. W. P. Hardesty (Illustrated description of present system prefaced by a brief description of the old system, now suspended). Eng News–May 21. 2000 w.

6186. Typhoid Fever and Water Supply in 66 American and Foreign Cities (Abstract and review of an address by John W. Hill, before the faculty and students of the University of Illinois, comprising an array of statistics). Eng News–May 21. 1500 w.

6188. Tests of the Tightness of a Vitrified Earthenware Water Conduit. Dabney H. Maury, Jr. (Abstracted from a paper read at the annual convention of the Illinois Soc. of Engs. & Survs. Presents tabulated results). Eng News–May 21. 1600 w.

6277. Uses and Advantages of a Public Supply of Compressed Air. Frank Richards (The use of compressed air for generating needed pressure in a water distributing system, in lieu of the present stand pipe or elevated tank is advocated). Am Mach–May 28. 1100 w.

6316. Lynn, Mass.—Its Water Supply, Water Works, and Pumping Engines (Illustrated description). Fire & Water–May 30. 3500 w.

6318. Some Recent Installations of Power Pumps in Small Water-Works Pumping Plants (Illustrated descriptions of water-works pumps, driven by gasoline engines). Eng News–May 28. 1800 w.

†6363. Cincinnati Water Supply and Typhoid Fever (Report of committee at the Nov. meeting of the Cincinnati Academy of Medicine). San–May. 2400 w.

†6409. Standard Prisms in Water Analysis and the Valuation of Color in Potable Waters. Albert R. Leeds (Account of attempts to substitute for the hollow wedges containing colored fluids used in nesslerizing, wedges of colored glass). Jour Am Chem Soc–June. 2300 w.

*6412. Animal and Vegetable Growths Affecting Water Supplies. Albert R. Leeds (Report of Chairman of a special committee of the American Water Works' Assn). Pav & Mun Engng–June. 1400 w.

*6414. Filtration of Public Water Supplies. Allen Hazen (The possibilities of purification of water supply by this method are greater than have hitherto been generally supposed. The conditions for effective filtration are stated and defects in practice are pointed out). Pav & Mun Engng–June. 4500 w.

6441. Does Pure Water Pay? (Money value of pure water). Eng News–June 4. 1200 w.

*6464. The Bacterio Chemical Examination of Polluted Waters. W. E. Adeney (Results of the latest researches). Engng–May 29. Serial. 1st part. 4000 w.

6467. Submerged Water Main at Columbus, Ga. (Illustrated description). Eng Rec–June 6. 500 w.

6468. The Queen Lane Pumping Station (Illustrated detailed description). Eng Rec–June 6. 1200 w.

†6501. Gutta-Percha Water Pipes. J. H. Morrison (An account of the use of these pipes, their advantages and disadvantages). Ind Rub Wld–June 10. 1700 w.

Miscellany.

6072. The Transportation of Goods in Towns and Cities (Editorial considering the problem of the cheaper transportation of goods through city streets, pointing out the fact that this work is at present done in an inefficient and extravagant manner, whereas it might, by a systematic organization, be conducted at a small part of its present cost). Eng News–May 14. 2500 w.

*6089. Scavenging-Disposal of Refuse. Charles Mason (Lecture delivered at the Sanitary Institute. Systems of collecting as well as final disposal are briefly considered, and the filling of city lots with refuse is deprecated as opposed to sanitary principles). San Rec–May 8. 1700 w.

*6410. Qualifications for Municipal Engineers. Charles Carroll Brown (A plea for a more thorough education). Pav & Mun Engng–June. 2300 w.

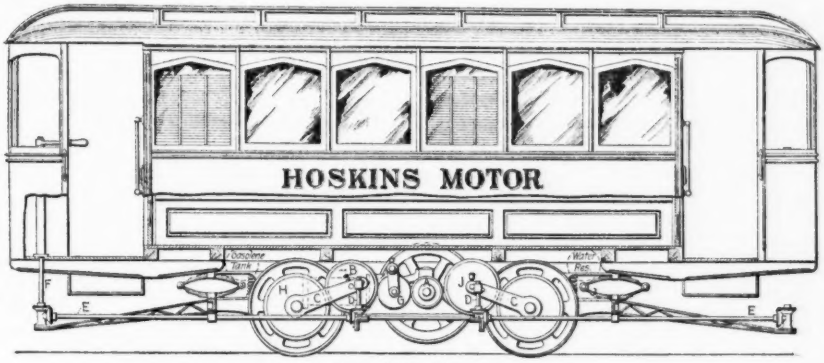
RAILROADING

Articles of interest to railroad men will also be found in the departments of Civil Engineering, Electricity, and Mechanical Engineering.

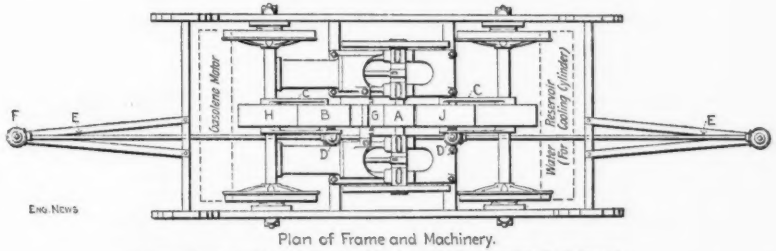
The Hoskins Gasoline Motor Car.

IN our November and February issues we gave some details of gas traction as applied to English and continental street railways. America comes forward with several improvements upon these systems, under the name of the Hoskins motor, which is thus described by the *Engineering News* (March 12); "As will be seen, the motor is carried underneath the car, and, together with the mechanism for transmitting the power, is closed in so as to be hid entirely from view. Two engines are used, both coupled to a transverse shaft, carrying at each outer end a 40 in. diameter fly wheel. These serve to give a steady motion and to overcome the inertia of starting. It is claimed that by this use of two engines more than twice the power is developed than would be the case with a single engine of the same dimensions. The cranks are in the same plane.

"At the center of the crank shaft there is a friction pulley, A, 12 in. in diameter and 8-in. face. A loose friction pulley, B, with an 8-in. face, is hung on the frame, C, which in turn swings on the axle of the driving-wheel, H. The frame, C, is actu-



Sectional Side Elevation.



Plan of Frame and Machinery.

THE HOSKINS GASOLINE MOTOR CAR FOR STREET RAILWAYS.

ated by the screw, D, by means of the gears and shafts, E and F, the latter shaft being controlled by the motorman. The pulley, B, bears against a fixed pulley on the driving-wheel, H. Between pulleys B and A is a swinging-pulley, G. Now, if shaft E is revolved so that the screw, D, pulls down the pulley, B, connection is established between the pulley, A, and the pulley, H, by means of the intermediate

pulleys, G and B, and the car moves ahead. As the shaft, E, is revolved so as to pull down the pulley, B, it also acts to push up the pulley, J, by which the car is run backward; thus the revolution of the shaft, F, in one direction drives the car ahead, and its revolution in another direction drives it backward. Of course it will be understood that the crank shaft and pulley, A, revolve continuously when the car is in operation, simply running idle when power is not being used to drive the car."

"The gasoline is carried in a steel cylinder, tested by a pressure of 2,000 lbs. per sq. in., from which it is admitted to the engine cylinders, vaporized and exploded by an electric spark, from a four-cell battery located under the car seats.

"To start the engines to operating, a crank is operated by the end driving-shaft so as to cause the necessary explosions. The cooling water is piped from the water tank, no pump being used."

This motor street car is being tested on the Wayne avenue and Fifth street railway, of Dayton, Ohio, but no results are yet available.

A Compound Locomotive in Suburban Service.

IT is rather remarkable, in view of the rapid development of the use of the compound locomotive, that there has been comparatively little publication of exact information with regard to the comparative results obtained from the new and the older types, under similar conditions. The figures below, copied from the *Railroad Gazette*, have, therefore, considerable interest, and would have more if the railroad official making the test had not been, as the *Gazette* regretfully says, "too modest to have his name or that of his company mentioned."

"Both the engines were built at the shops of the railroad company, and are identical in every particular, save in the front end. The compound device was furnished by the Richmond Locomotive Works, but was not attached or supervised by them. In other words, the railroad company simply bought a pair of cylinders from the Richmond Locomotive Works, as they would have bought any other furnishing of a locomotive.

"An interesting feature of the statement is its bearing on the question as to whether or not a compound is suitable for suburban service. It would seem that in this case, in the 24 trips, the compound made 494 stops, and reduced speed to less than three miles per hour 148 times, and must have picked up train and got under way with great ease, as it actually spent less time on the road with train and in running than the simple.

"The conditions were so much alike with the two engines that they must be accepted as the same, although it is manifest that the train was light for such heavy engines; which was against the compound as it is especially adapted for hard service. The steam pressure was also against the compound, being lower than the simple, whereas the reverse is the usual practice; and for 10 trips the compound heated the train.

"The compound saved 11,570 pounds of coal, or 20 per cent., which will not be appreciably affected by the slightly heavier train of the simple engine. The pounds of coal per engine-mile show the same percentage in favor of the compound. The coal per car-mile only shows about 14 per cent. saving, owing to the lighter load of the compound.

COMPARATIVE WORK OF SUBURBAN ENGINES.

Kind of engine.	Richmond Compound.	Simple.
Number of trips made	24	24
Average steam pressure	151.1 lbs.	156.5 lbs.
Total weight of water evaporated	273,386 "	318,771 "
Total weight of coal consumed	46,630 "	58,200 "
Temperature of feed water	61° F.	62° F.
Weight of water evaporated per pound of coal	5.86 lbs.	5.47 lbs.
Average number of cars hauled	6.07	6.53
Car miles	3,352	3,611
Engine-miles with train	552	552
" " light	102	102
Total engine-miles	654	654
Pounds coal per car-mile	13.9 lbs.	16.117 lbs.
" " " engine-mile	71.3 "	88.99 "
Number of hours under steam	142 hours.	144 hrs., 30 min.
Number of hours on road with train	31 hrs., 9½ min.	32 " 3 "
Number of hours actual running	27. " 8¾ "	27 " 43¾ "
Number of hours on road with light engine	8 " 44	7 " 40 "
Number of trips steam heat was in use	10	none
Total number of stops made	494	516
Times speed reduced to less than 3 miles per hour	148	122
Weather report	2 days clear, 2 days clouded, 2 days rain	2 days clear, 1 days clouded

"The compound has been continually in service, day in and day out, since it was built three months ago."

The English Railway Clearing-House.

THE English railway clearing-house is no doubt an outgrowth of conditions essentially different from those prevailing on this side of the water, but the principle is capable of wide adaptation, and an organization analogous in scope, but modified as to detail, would seem to be directly in line with modern American railroad tendencies.

The day of association for mutual advantage and joint economy has fully dawned, and it is a little strange that the newly-recognized principles have not yet found application in so manifestly appropriate a direction as this.

The workings of the English system were fully described by Dr. William Taussig before the Commercial Club of St. Louis in an admirable paper, from which large extracts have been printed in the *Railroad Gazette*. A brief summary of the principal points is given in the quotations below :

"The salient features of the organization are :

"*First*. It has nothing to do with the fixing of rates.

"*Second*. It undertakes only the division and settlement of the revenue derived from freight and passengers which pass over more than one line.

"*Third*. It has nothing to do with local traffic.

"*Fourth*. Each line determines its own local rates. Where there is no agreement between connecting lines as to rates on joint traffic, the clearing-house collects the sum of the local rates. If disputes arise, it makes no distribution of amounts collected, but holds them until the parties agree among themselves, or agree to submit the dispute to the arbitration committee of the clearing-house. If so submitted, the decision is final.

"*Fifth*. It pays out only balances found to be due to each road upon monthly settlements.

"*Sixth*. It keeps control, through its own officers and employees, of all movements of all the rolling-stock belonging to one company over the lines of another, notes their mileage, and distributes the charges arising therefrom.

"*Seventh*. It attends to the tracing aud recovering of all lost packages in freight or passenger trains, and to the settlement of these losses if not recovered, and determines the responsibility, or proportion thereof, of each line which has carried them.

"*Eighth*. Besides collecting and distributing monthly revenues arising from the carrying of freight and passengers over connecting lines, it supervises and controls the general and postal parcel department, which is similar to our express business. Settlements of revenues arising from the parcel department are made only every six months.

"It will be seen from the above that the railway clearing-house deals not merely with accounts, but with almost all questions that can arise between the different railway companies. The chief departments into which it is organized are the following : (1) the department for freight traffic ; (2) department of passenger traffic, of which the parcel department is a branch ; (3) department for the tracing of cars of one line running over another line, and for recording the mileage thereof ; and (4) department for lost articles.

"*First*. The department for freight traffic. The main work of this department is the monthly division of charges for the transportation of all classes of freight which pass over more than one railway. For the purpose of division the department receives from every station a report of the whole of the goods dispatched every day, and also of the goods received ; and the first task of the department, when all these have come in, is to group them together, so that shipments and receipts may be easily compared with one another. If differences appear, they are sent to the respective stations, and no settlement is made until the difference is cleared up. The report of the two stations having been verified, the report of the sending station, which generally collects the entire amount,

is transferred to what is called the 'settlement form,' and the total amount of freight divided between the railways concerned.

"*Second.* The passenger department, which undertakes to settle the accounts of all interchanging traffic, animate and inanimate, conveyed by passenger trains.

"*Third.* The mileage department. The principal work of this department is the recording of the numbers and the tracing of each individual vehicle from the time it leaves until it returns home, the careful noting of the exact route traveled, and the time occupied in running the respective distances. It deals with the rolling-stock of every company whenever it passes from the parent line, watches and records its progress and return, and apportions the charges accruing from its use.

"*Fourth.* The loss and damage department is carried on on a similar line with the others, but one is astounded, when reading the reports, at the rapidity with which lost goods are traced, forgotten passenger parcels recovered and returned, and how the actual total of losses is reduced to a minimum through the admirable system adopted.

"It remains only to show, in a general way, how the system operates. For purposes of division, the clearing-house receives from every station on every line:

"1. A monthly report of the entire freight dispatched at the station, where from, the initial of the car and the car number, what charges, if any, attached thereto for drayage, loading, etc., whether the freight is deliverable to consignee at the station or at his premises, and whether charges are prepaid or collectible.

"2. A monthly report of each ticket sold, the number thereof, the initial and terminal point, the class, amount received, and the lines over which ticketed.

"3. At the receiving station the same kind of report is made of goods received, which must tally precisely with the report of goods forwarded. All passenger tickets collected by conductors on trains are sent to the clearing-house, there assorted and compared with the report of the selling agent, and, unless the reports of the selling agent correspond with the tickets received, or unless the report of freight received corresponds with the report of freight forwarded, the clearing-house at once sets about to trace inaccuracies.

"4. All companies, parties to the clearing system, are required to give to the clearing-house security for the due payment of clearing-house balances to such amount and in such shape as the superintending committee may order.

"5. The bankers of the clearing-house are supplied with the names of the companies parties to the clearing system, and are instructed to make no payment to any railway company not included in the list.

"There are innumerable provisions in the rules relating to division of receipts, of expenses, payment of balances, etc., and the above is simply intended to give an outline of the system in general.

"The total gross railway receipts in the United Kingdom in 1894 amounted to £84,310,831, of which £30,000,000, or about 37 per cent., passed through the clearing-house in settlements. These figures show best the enormous task of which it relieves its members, the railways."

THE ENGINEERING INDEX—1896.

Current Leading Articles on Railway Affairs in the American, English and British Colonial Railroad and Engineering Journals—See Introductory.

*5550. The Cost of Railway Working (American figures for maintenance of way and equipment, annually for six years, are given as object lessons in economy, and the English situation compared). Ir & Coal Trs Rev–April 10. 1100 w.

*5551. The Snowdon Mountain Railway Accident (Account of the accident at the opening of the line). Trans–April 10. 1000 w.

*5553. The "Crawl to the South" (Contains some statistics of punctuality of trains on the principal English railroads having a London terminus, interesting in comparison with U. S. practice). Trans–April 10. 900 w.

*5554. Notes on Light Railways Abroad: Their Permanent Way and Rolling Stock (The first number deals with Belgian light railways, especially the construction and cost of permanent way and the problem of transhipment to

We supply copies of these articles. See introductory.

standard gauge roads). Eng, Lond–April 10. Serial. 1st part. 6000 w.

*5558. Permanent Way. J. C. (A discussion of the loss of power due to rail deflection under the car wheels, with incidental commendation of the American passenger coach). Eng, Lond–April 10. 700 w.

*5559. The Accident on the Snowdon Railway (An account of the accident, with map of the line and illustrations from photographs of the wreck). Eng, Lond–April 10. 600 w.

*5592. The "Dunalastair" (Brief illustrated description of new express locomotive for the Caledonian Railway). Loc Engng–May. 500 w.

*5593. Old Philadelphia and Reading Locomotives (Notes and photographs of some old type locomotives). Loc Engng–May. 400 w.

*5594. Testing Slide Valves on Purdue University Locomotive (Describing the joint investigations of the University and the Master Mechanics' Committee, and criticising the failure of railroad corporations to assist in such work). Loc Engng–May. 900 w.

*5595. Distortion of Flue Sheets (Account of some tests indicating that the sectional expander causes great distortion, while the roller expander is free from any such defect). Loc Engng–May. 300 w.

*5596. Handy Air Lift (Illustrating a useful substitute for the block and tackle, for changing stacks and loading wheels). Loc Engng–May. 60 w.

*5597. Accident on the Great Northern Railway of England) Brief account of the accident, with photographs of the track and the wreck). Loc Engng–May. 200 w.

*5598. The Original Extension Front (Letter from A. M. Waitt, master car builder of the L S. & M. S. railroad, describing and illustrating his original spark arresting device and its early reception). Loc Engng–May. 850 w.

*5599. Advantage of Station Platforms (Arguing for station platforms on a level with car platforms, on the grounds of time saving and increased comfort of passengers). Loc Engng–May. 450 w.

*5600. A Device for Turning Worn Crank Pins (Description and illustration of an interesting device for truing up pins while in the wheel). Loc Engng–May. 200 w.

*5601. Graphics of Truck Arch Bars (The importance of proper designing, exhibited by designs showing the stresses in correctly and incorrectly proportioned arches. The subject is urged upon the attention of the M. C. B. Association). Loc Engng–May. 1100 w.

*5602 Roller for Car Axle Journals (Description of a tool for finishing journals, which is claimed to be almost a specific for hot boxes). Loc Engng–May. 250 w.

*5603 Some Fitchburg Kinks (Description of some useful devices used at the Fitchburg R. R. car-shops). Loc Engng–May. 400 w.

*5604 Shop Kinks at Valley Falls. O. H. R. (Interesting hints of useful shop practice and tools from the N. Y., N. H. & H. R. R). Loc Engng–May. 900 w.

*5605. Locomotive Details—Boston & Maine Railroad. O. H. R. (The details of which dimension drawings are given, are the rocking grate, oil cup for eccentric strap, brick arch and exhaust damper). Loc Engng–May. 450 w.

*5606. Central of Georgia Railroad Air-Brake Instruction Plant. W. W. Elfe (A condensed description with photograph). Loc Engng–May. 250 w.

*5607. Solution of Conger's Problem. C. B. Conger (Account of experiment showing the possibility of leaving the leakage groove uncovered after several reductions). Loc Engng–May. 300 w.

*5608. Does High Steam Pressure Increase the Danger of Boiler Explosions? (Editorial arguing that faulty inspection and not high pressure is the dangerous element. Loc Engng–May. 1400 w.

*5609. Wear of Tires Affected by Form of Rail Head (Extracts from a paper by Prof. P. H. Dudley, being a review of experience on the N. Y. C. R. R. with different patterns, the conclusion being highly favorable to the broad-head). Loc Engng–May. 900 w.

5610. Prospects for Railway Construction in 1896 (A summary of recent conditions, and of lines on which construction has begun or is promised). Ry Age–April 25. 700 w.

5611. The Shipper and the Law (From the circular of the Kansas City transportation bureau calling attention to the liability of shippers under evasions of the inter state commerce law). Ry Age–April 25. 500 w.

5612. Chicago's Railways (The number of roads entering the world's greatest railway center. A correction of the commonly quoted figures and a graphic diagram enumerating the existing lines). Ry Age–April 25. 800 w.

5613. Compressed Air Locomotives (General description and photographs of those in use on cotton wharves of New Orleans & Western R. R). Ry Age–April 25. 400 w.

5614. Increase of Heating Surface in Locomotives. C. W. Whitney (Communication urging the great economy of fuel to be expected from the use of the Serve internally ribbed tube). Ry Rev–April 25. 2500 w.

5615. Syracuse Station—N. Y. C. & H. R. R. R. Bradford L. Gilbert (Description, sectional drawing and plan of section, trainshed and tracks). Ry Rev–April 25. 1800 w.

5616. Liquid Fuel Burning.—Holden System (Photograph and description of liquid fuel burning locomotive on Great Eastern Railway, England). Ry Rev-April 25. 400 w.

5617. Steel Underframes for Freight Cars. D. L. Barnes (Contributed to the discussion on large freight cars at the meeting of the N. Y. R. R. Club. A prediction as to the limited agreement likely to be reached upon questions of construction, and the general agreement as to shape sof roller sections). Ry Rev–April 25. 800 w.

5618. Piston Travel of Air Brakes (Editorial reviewing the conclusions of Air Brakemen's Convention). Ry Rev–April 25. 1100 w.

We supply copies of these articles. See introductory.

5619. Ribbed Tubes for Locomotives (Editorial review of European practice and experience). Ry Rev–April 25. 1600 w.

5621. Air Compressors on the Santa Fé Ry. (A list of tools operated by air at the shops of this road). Ry Rev–April 25. 400 w.

5627. The Work of the Texas State Railway Commission (Editorial review of the work as set forth in the last report of the Texas Commission, approving the position as economically and politically correct, and stating that the work that has been done could be profitably studied by other States. They have attempted to base railway rates upon the cost of service). Eng News–April 23. 1500 w.

†5638. The Working of Automatic Brakes on Railways in India (Some notes on the progress of equipment and accident percentages of trains). Ind Engng–March 21. 800 w.

5681. The Destructive Action of Locomotive Driving Wheels (A statement of the evils of overbalancing, and suggestion of means for their reduction). Sci Am–May 2. 1200 w.

*5702. Coaling Station at Wabash.—Cleveland, Cincinnati, Chicago & St. Louis Railway (A description, illustrated by half tones, plans, and sectional drawings, showing the conveyer system for handling both coal and ashes). Am Eng & R R Jour–May. 1200 w.

*5703. Ten-Wheeled Locomotive—New York, Chicago & St. Louis Railway (Description of construction, with dimensions, and illustrated by sectional drawings of locomotive-boiler and details of link motion). Am Eng & R R Jour–May. 1600 w.

*5704. Locomotive Grates (A discussion of the nature of combustion and the effects upon it of the environment of the fire). Am Eng & R R Jour–May. 2500 w.

*5705. Hopper Gondola Car of 60,000 Pounds Capacity—Central Railroad of New Jersey (A brief description of some details of design, with drawings of the car, pocket castings and draft-rigging). Am Eng & R R Jour–May. 500 w.

*5706. Locomotive Boiler with Mason-Work Firebox. A. Socher (Translated from the *Organ für die Fortschritte des Eisenbahnwesens*, describing the construction and service experience and indicating the special advantages to be expected). Am Eng & R R Jour–May. 1800 w.

†5709. The System of the Staten Island Electric Railroad Company (A fully illustrated detailed description of the system, power house, roadbed and overhead construction and terminals). St Ry Jour–May. 3500 w.

†5710. Studies in Economic Practice:—St. Paul—Minneapolis. C. B. Fairchild (The first paper is devoted to operating expenses, receipts, maintenance, discipline and shop practice). St Ry Jour–May. Serial. 1st part. 3000 w.

†5711. Comparative Wheel Record (A tabulated comparison of five makes of wheel under severe service. Payment for wheels on a mileage record basis is recommended). St Ry Jour–May. 400 w.

†5712. Safety Switches. John A. Beeler (Communication describing and illustrating a device used in Denver with great satisfaction and economy). St Ry Jour–May. 600 w.

†5713. Insulation of Underground Cables. E. J. Spencer (Comment on a former article: the communication sharply criticises paper and fiber insulation). St Ry Jour–May. 1000 w.

†5714. Freight, Mail, Express and Baggage Service (A compilation of the experience of 45 roads touching the profit of such service, with editorial review). St Ry Jour–May. 3900 w.

†5715. The Law of Negligence, with Some Statistics (A review of John Brooks Leavitt's work compiling cases, codifying the law and classifying decisions. Some interesting data are abstracted). St Ry Jour–May. 3000 w.

†5716. Electric Conduit Construction in Washington (Description, with illustrations of some points in the Metropolitan R. R. Co.'s practice, especially with reference to the construction of insulators). St Ry Jour–May. 1300 w.

†5717. High Speed Line Between Washington and Mount Vernon (A brief account of construction of way, equipment and power house). St Ry Jour–May. 700 w.

†5718. Novel Seashore Electric Railway (An English seaside resort railway which runs on deeply submerged tracks is described and illustrated). St Ry Jour–May. 600 w.

†5719. The Recording Wattmeter in Railway Practice. Caryl D. Haskins (A description of the Thomson recording wattmeter and exposition of the value of a meter in street railway work). St Ry Jour–May. 1900 w.

†5720. A Résumé of the Opposite Joint Discussion. James A. Emery (Suggesting a compromise by very slightly breaking joints). St Ry Jour–May. 800 w.

†5721. Signals on Electric Railways (A discussion of methods for protecting crossings and blocks between turnouts, and for emergency communication with power station) St Ry Jour–May. 2400 w.

*5793. The Enlargement of Liverpool-Street Station, Graat Eastern Railway (The article is chiefly devoted to description of design and construction of a railway bridge. It is interesting as illustrating the solution of difficult problems attendant on enlarging railroad facilities in the heart of a city). Eng, Lond–April 24. 3300 w.

*5795. Compound Express Engine, Great Southern and Western Railway (Description and dimensions with drawing of change valve. No accurate data of performance or economy). Eng, Lond–April 24. 500 w.

*5798. The Railway Zone Tariff System in Russia (Gives details of the system, and tabulation of former and existing (reduced) fares. A large increase of travel reported since the reduction, and favorable predictions made for the future of Russian railways). Eng, Lond–April 24. 1000 w.

5806. Types of High-Speed Locomotives (Editorial discussion with diagram illustrating latest American and English types and a prediction as to probable development). Ry Mas Mech–May. 900 w.

5807. An Approaching Problem in Knuckle

Breakages. Knuckle (Communication suggesting the loosening of breakages at the link and pin hole by making the inside and outside surfaces of the knuckles convex, thus allowing a rocking motion). Ry Mas Mech–May. 1400 w.

5808. The Draft Gear Question (Communication, with plans showing present and proposed construction, the improvement consisting in bringing the line of draft and buffing strains to the center of the sills, instead of several inches below as at present). Ry Mas Mech–May. 1700 w.

5809. Painting a Locomotive in Ten Days. A. Ashmun Kelly (A review of an old discussion in the Master Car Painters' Assn. Several plans are given, and a symposium of opinion upon results). Ry Mas Mech–May. 1600 w.

5811. The Northwestern and the Union Elevated Railroads of Chicago (The first number describes the projection of the route, difficulties encountered, standard structure adopted, and gives descriptions and fine illustrations of general construction, and many special details). R R Gaz–May 1. Serial. 1st part. 2800 w.

5812. The Baltimore and Ohio Equipment Contracts (A brief but quite complete summary of the contracts to be let for various types of engines and cars, and an abstract of specifications for each). R R Gaz–May 1. 1200 w.

5813. The Air-Brake Men's Association (Concluding account of the Boston meeting, containing committee reports on maintenance of freight and passenger brakes, air-brake signals and main reservoir and connections, with topical discussions of various minor points). R R Gaz–May 1. 6500 w.

5814. The Latest Information about Car Lighting (Editorial comment, with abstracts, directing attention to the report of Profs. Chandler and Denton to the Lehigh Valley R. R. The report is highly favorable to the Pintsch lamp and gas). R R Gaz–May 1. 1400 w.

5815. Concerning Specifications (Editorial, questioning the economy of specifying individual makes for component parts in car construction, exemplified by illustrations from correspondence and practice. Discussion is suggested). R R Gaz–May 1. 1600 w.

5831. Signal Department Standards—Pennsylvania Lines West of Pittsburg (A review of the pamphlet recently issued by the company. The general principles of signalling are fully given, signal standards illustrated by diagram and note made of recent changes of specifications of construction, and special points in the practice of these lines). Ry Rev–May 2. 1400 w.

5832. An Automatic Air Brake Recorder (Mr. O. G. R. Parker's paper before the Northwest Railway Club, describing a continuous disc pressure recorder, attachable at any point on the train, as a check on the engine runner). Ry Rev–May 2. 1200 w.

5833. Some Convenient Pneumatic Appliances (These appliances for railroad shops, quite fully explained by illustrations, are a mud ring riveter, steam pipe ring chuck, crown bar bolt-facer, and painter for painting freight cars). Ry Rev–May 2. 800 w.

5834. Necessary Railroad Legislation (Recommendation of the Illinois Railroad and Warehouse Commission that legislative enactment should be passed, restraining unnecessary and destructive new roads. Text and editorial comment). Ry Rev–May 2. 1600 w.

*5859. The Railways of Japan (An excellent review of the history, present status, and the conditions affecting development, topographical, geographical, meteorological, seismic and political. Comment is made upon the growth of American influence, and English manufacturers urged to increase their representation). Trans–April 24. 3000 w.

*5860. The Tramways of the United Kingdom (Statistical tables devoted to mileage, capital investments, equipment, power and operating receipts and expenditures). Trans–April 24. 350 w.

5903. The Railway up the Jungfrau (A brief description with illustrations. The road will be operated by electricity, developed from the Lauterbrunnen falls; it will be about eight miles in length, largely in tunnel; the ascent of the cone will be completed by an electric elevator, running in a shaft bored in the rock). Sci Am Sup–May 9. 500 w.

5907. Ditching Car; St. Louis Southwestern Ry. (Describing and illustrating a portable device for maintaining railroad ditches or lowering track. The machinery is operated by compressed air and is said to ditch and dress embankments on one side of the track, for 1½ or 2 miles per day). Eng News–May 7. 1500 w.

5908. Railway Bridges of Short Span. F. W. Wilson (Calls attention to the fact that short-span bridges are much more numerous than long span and equally disastrous in collapse; describes and illustrates rail floor, longitudinal trough and special design bridges up to 16-ft. clear span). Eng News–May 7. 1600 w.

5929. Why do Rails Break? A. R. V. Dormus (From a paper read before the Austrian Soc. of Civ. Engs. Condensed from the *Zeitschrift des Oest. Ing. and Arch. Vereins*, by Julius Meyer. The paper goes into an extended discussion of chemical, physical and etching tests, urging the importance of the last named. The great differences in strength are attributed to segregations in the ingots, and suggestion is made that main track rails be selected from the lower ⅔ of rolled beams only). R R Gaz–May 8. 2400 w.

5930. Cast Iron Railroad Bridges in England (The article gives statistics, taken from a recent Blue Book, and is an interesting exhibit of the extensive use of cast iron in English bridges). R R Gaz–May 8. 1000 w.

5931. The Results of a Broken Rail (An editorial discussion of the St. Neots (England) accident, and of heavy weights on engine drivers, with some results of chemical and physical tests of broken rail). R R Gaz–May 8. 1600 w.

*5938. The Fruits of Fraudulent Railroad Management. J. Selwin Tait (Showing the source of distrust in United States corporations, and the legislation necessary to remove the same). Eng Mag–June. 4300 w.

5994. Uniformity in Storehouse Stock (Extracts from a paper by S. F. Forbes before the Northwest Railway Club, recommending adoption of uniform material on railways, with editorial). Ry Rev-May 9. 2000 w.

5995. European Electric Railway Statistics (Statistics of mileage, power, equipment and construction types. From *L'Industrie Electrique*). Ry Rev-May 9. 500 w.

5996. Body Bolster, 70000-lb. Car—Northern Pacific Railway (Description of construction with detail drawings). Ry Rev-May 9. 800 w.

5997. Mr. Justice Harlan's Dissenting Opinion in the Import Rate Case (An abstract. The Justice holds that the import rate is a discrimination against the native, putting him at the mercy of foreign combinations). Ry Rev-May 9. 800 w.

5998. Coal Hoppers on Standard Tenders—A. T. & S. F. Ry (Description and drawing of a substitute for the rack and boards). Ry Rev-May 9. 200 w.

6000. Statistics—Lake Shore & Michigan Southern Railway Company—Twenty-sixth Annual Report (The statistics are of freight and passenger traffic, earnings and expenses annually for twenty-five years, and are used to point an editorial in favor of absolute maintenance or material advance of rates). Ry Rev-May 9. 1200 w.

6002. Third Rail Supports—Lake Street Elevated Railroad (Description with drawings of truck attachment and photograph of insulator. The insulation is said to be unusually good). Ry Rev-May 9. 700 w.

6003. Power to Change Rates of Fare (Correction of mis-reported Chicago decision. It is stated that the right to fix rates of fare must be exercised at the time of granting franchise). Ry Age-May 9. 600 w.

6004. The Successful Passenger Man. George H. Daniels (States the five requisites to be knowledge of the line, industry, courtesy, promptness and honesty, and discusses each separately). Ry Age-May 9. 2000 w.

6005. A Broken Rail Accident on an English Railway (An account of the St. Neot's accident, condensed from the *Railway Engineer*. Describes the physical features of the accident in detail, with drawings of the broken rail). Ry Age-May 9. 1300 w.

6006. Relations of Railway Employés to the Public (Extract from an Ill. Cent. R. R. circular with comment by Mr. Harahan on the rule enjoining employés to report at once anything they may notice detrimental to the company's business, and to strive to accommodate the public). Ry Age-May 9. 800 w.

6007. Some Recent Coupler Tests (Record of drop tests conducted under R. R. supervision, with specifications adopted to govern acceptance of couplers). Ry Age-May 9. 200 w.

*6008. Railway Development in Rhodesia (A brief report of a conversation with the contractors, giving some facts about progress and opinions as to the political significance of the work). Trans-May 1. 1500 w.

6033. The Chamounix Railway. Translated from L'Illustration (General description of the proposed adhesion and rack railroad, to ascend 6300 ft. from Chamounix to the Mer de Glace). Sci Am Sup-May 16. 1000 w.

6042. Weight of Passenger Cars (A review of the American practice of building very heavy cars, and suggestion of return to lighter weights in the interest of increased speed possibilities). R R Car Jour-May. 1300 w.

6043. The Rules of Interchange from the Car Owner's Standpoint. Maurice (Communication representing the high value of private equipment to the railroad, and urging better and more liberal treatment of the owners, especially in the matter of repairs). R R Car Jour-May. 1600 w.

6044. Some Observations on Wheels. George S. Hodgins (Devoted chiefly to an argument as to the over-rated importance of depth of chill, and the underestimated value of good balancing and careful mounting). R R Car Jour-May. 1800 w.

6045. Passenger Carriage; Great Western Railway of England (Description, elevation and plan). R R Car Jour-May. 500 w.

6046. Paint Shop Staging (Description and drawings of a device to replace horses and planks in car-painting) R R Car Jour-May. 700 w.

*6047. Caledonian Passenger Express Engines (A full description with measurements and photo-engravings). Ry Wld-May. 450 w.

*6048. London Southern Tramways (Gives description and illustrations of double-deck and water cars, map of territory served, and data of fares, earnings, etc). Ry Wld-May. 900 w.

*6049. Side Pressure Ball Bearings (Describing and illustrating the application of ball bearings to street railway car service). Ry Wld-May. 1400 w.

*6050. Irish Railways and Their Purchase by the State (An argument for government ownership). Ry Wld-May. 3600 w.

*6051. Isle of Man Electric Tramways (A descriptive account of the system with statistical figures). Ry Wld-May. 2200 w.

*6052. Electric Traction Recommended for Glasgow (Report of a town council sub-committee, based upon a review of the situation in the principal continental cities). Ry Wld-May. 1400 w.

6053. The Government's Argument in the Joint Traffic Association Injunction Suit (An abstract of the government's position, as presented by Dist. Atty. Wallace Macfarlane, with editorial). R R Gaz-May 15. 2800 w.

6054. History of Electric Locking of Railroad Signals. V. Spicer (A paper read before the Railway Signaling Club, Chicago. The paper is devoted chiefly to the less familiar history of the application of the track circuit in connection with electrical locking of interlocking machine levers, and an argument for this practice). R R Gaz-May 15. 2200 w.

6055. The New Baltimore and Ohio Station in Baltimore (A description of the building with perspective and plan and plot of the depot grounds). R R Gaz-May 15. 1400 w.

We supply copies of these articles. See introductory.

6056. Railroad Matters in England. W. M. Acworth (London letter: the topics are accidents, punctuality, competition and London and Paris traffic). R R Gaz-May 15. 1400 w.

6057. The 109th Street Collision (The opinion of the Railroad Commissioners is criticised, and an argument made for the policy of written orders for each train all the time). R R Gaz-May 15. 800 w.

6058. The Reports of the Lake Shore and the Michigan Central (A statistical review of mileage, passenger and ton-mile, expenses and earnings). R R Gaz-May 15. 800 w.

*6102. The Consolidation of the London Tramways (Editorial argument in favor of a lease to a syndicate, with criticism of an adverse county council committee report. The conduit system of electric transmission is alluded to as practicable and successful). Engng-May 8. 2400 w.

*6106. Permanent Way (A series of communications devoted principally to discussion of English practice. Contains interesting comment upon the limit of advantageous rigidity). Eng, Lond-May 8. 3000 w.

*6107. The Fire Boxes of Locomotive Engines (A discussion of the difficulties of the internal fire-box and the defects of ordinary methods of staying, with favorable mention of the Belpaire fire box). Eng, Lond-May 8. 1700 w.

†6108. How Can Our Station Service Be Improved? F. E. Hoff (Paper read before the N. Y. R. R. Club. The recommendation is chiefly the institution of a station service department, with separate superintendent, inspectors, etc. This suggestion is amplified and explained, and followed by an extended discussion). N Y R R Club-April 16. 15500 w.

6113. Packing for Piston Rods and Valve Stems (A review of a paper by T. P. Purves, Jr., before the New England Railroad Club. The conclusions are favorable to metallic packing in preference to hemp, and some figures of maintenance cost are given). Ry Rev-May 16. 1200 w.

6114. The Liability of Employers (Summary of a case decided against the railway on the ground that under the circumstances the operator was a representative of the company and not a fellow servant of the injured employé. With editorial review). Ry Age-May 16. 2000 w.

6115. A New North and South Line. The K. C. P. & G. Route from the Grain Fields to the Gulf (Account and map of an important undertaking, predicted to be the inception of a new trunk line). Ry Age-May 16. 800 w.

6116. The "Black Diamond Express" (Description and photographs of the new Lehigh Valley train between New York and Buffalo). Ry Age-May 16. 700 w.

6117. The Evolution of a Fast Engine—How the Reading's High-Speed Passenger Engine with a Single Pair of Drivers Was Developed (The evolution is displayed by photographs of the successive stages, and measurements of the later types). Ry Age-May 16. 700 w.

*6120. Cost of Motor Maintenance (Part I is devoted to review of figures and records of Cleveland and Elyria, Springfield (Mass.), Nashville, Ogden, Montgomery (Ala.), Madison, Wis., Salt Lake City and some smaller roads). St Ry Rev-May 15. Serial. 1st part. 2500 w.

*6121. Testing Motors at Schenectady (Description and illustration of method in use at General Electric Company's Schenectady factory). St Ry Rev-May 15. 150 w.

*6122. A Problem in Street Railway Construction (The problem was connected with the change of cable road location (due to an extension of the stock yards) without interfering with regular traffic on the old line at any change point). St Ry Rev-May 15. 1600 w.

*6123. The Albany-Troy Electric Express Service (A brief account of the plans and operation, with illustrations of forms used and tariff rates). St Ry Rev-May 15. 1300 w.

*6124. Care of Commutators of Street Railway Motors. Walter C. Smith (Methods of cleaning and treatment to avoid sparking). St. Ry Rev-May 15. 700 w.

*6125. Brooklyn Heights Railroad to Carry Express (Introduction of express service on a large electric system). St Ry Rev-May 15. 1000 w.

*6126. First Three Phase Electric Railway in the World (Comment upon the electric tramway at Lugano, Switzerland). St Ry Rev-May 15. 450 w.

6147. Rapid Transit Street Railways. R. D. Fisher (A brief summary of all laws enacted by the legislatures of the respective States in 1895 pertaining to rapid transit on street railways, together with the book references). Elec Ry Gaz-May 10. 600 w.

6187. Electric Controller for Grade Crossing Alarm Signals (Illustrated description of a new device). Eng News-May 21. 500 w.

6189. A Geared Locomotive for Contractors' Use (Illustrated description with table of dimensions). Eng News-May 21. 800 w.

6190. The Joint Traffic Association's Defense (A synopsis of Mr. James C. Carter's brief for the defense, in the suit brought by the Government to dissolve the Association. With editorial review). R R Gaz-May 22. 4000 w.

6191. The Present Status of the Compound Locomotive in France (The first part reviews the recent rapid development of the compound locomotive in France and describes standard types, with measurements, and records of comparative tests. Illustrated with sectional and detail drawings). R R Gaz-May 22. Serial. 1st part. 2200 w.

6192. The Pecksport Connecting Line of the N. Y., O., & W. (A typical example of modern grade elimination, with calculation of resultant saving). R R Gaz-May 22. 400 w.

6193. A Compound Locomotive in Suburban Service (Interesting comparative statement of simple and compound locomotives, identical in everything except front end). R R Gaz-May 22. 500 w.

6194. Railroad Expenditures for Improvements and Equipment (A collation of recent and contemplated expenditures for the information of contractors and manufacturers). R R Gaz-May 22. 5000 w.

6195. April Accidents (A classified table, with descriptive comment). R R Gaz-May 22. 2200 w.

6196. The English Railway Clearing House (Extracts from a valuable descriptive paper, read by Dr. William Tausig, before the Commercial Club of St. Louis). R R Gaz-May 22. 1500 w.

6212. Railroad Ethics. H. D. Judson (Abstract of a paper read before the Western Railway Club. The writer considers present systems of discipline antiquated and defective, and pleads for broader and more advanced ideas. With editorial). Ry Rev-May 23. 4000 w.

6213. Philadelphia and Reading Tunnel and Subway in Philadelphia (Description, bird's-eye view and sectional drawings of an important work for elimination of grade crossing). Ry Rev-May 23. 1600 w.

6214. Railway Corporations (Railway rates. Limitations to the state's control of rates. Paper prepared for the convention of Railway Commissioners by A. B. Stickney). Ry Rev-May 23. 6000 w.

6215. Car Service Reforms (A forthcoming report to the International Association of Car Accountants, with an editorial argument for daily rental instead of mileage, for disregard of line marks, and a prediction of a great pool for joint ownership). Ry Age-May 23. 3000 w.

6216. The Effect of the Interstate Act. W. P. Clough (Read before the National Convention of Railroad Commissioners. The communication attributes rate cutting to the influence of important shippers, and depreciates the effect of the Interstate Commerce Act in maintaining rates). Ry Age-May 23. 3500 w.

6217. Illinois Central Improvements at Chicago (Description and full illustration with map, of an important piece of track depression). Ry Age-May 23. 3500 w.

6218. The Pooling of Engines (A discussion of the advantages and defects of the system in the Western Railway Club). Ry Age-May 23. 3000 w.

*6220. Power-Worked Tram Cars (The Serpollet system of steam propulsion described and illustrated with commendation for efficiency and economy). Engng-May 15. 2500 w.

*6239. Mallaig Railway and Harbor (Description and map of a West Highland Railway feeder of scenic and economic importance). Eng, Lond-May 15. 1500 w.

*6240. Economical High-Power Locomotives. James Dunlop (Description of application of Corliss valves to a Paris-Orleans locomotive, with general and detail drawings). Eng, Lond-May 15. 1400 w.

*6248. The Survival of the Fittest. Philip Dawson (Favoring electricity, and the trolley system, as motive power for street railways. What has been accomplished in the United States is cited in favor of the system with tables of traffic, expenses, &c). Elec Rev, Lond-May 15. Serial. 1st part. 2500 w.

*6253. Dublin Electric Tramways (Illustrated description of the tramway between Dublin and Dalkey, which is an important work in the history of electric railways of that country). Elec Eng, Lond-May 15. 5400 w.

6291.—$1.50. The Construction of a Light Mountain Railroad in the Republic of Colombia. E. J. Chibas (An excellent and very full description of typical construction in undeveloped country, where cheap first construction is essential, with map and half tones). Am Soc of Civ Engs-May. 8500 w.

6308. The Love Conduit System on Amsterdam Avenue (Illustrated description of construction and equipment. The line has not yet emerged from the experimental stage). Elec Ry Gaz-May 25. 1000 w.

*6309. The Altoona Shops of the Pennsylvania Railroad (The first article is devoted chiefly to a general description of the shop arrangement, buildings, and some special tools and methods. With editorial on car wheel matters). Am Eng & R R Jour-June. Serial. 1st part. 5800 w.

*6310. Should a Railroad Adopt Electric Motive Power to Meet the Competition of Electric Suburban Lines? (Extracts from report of Mass. R. R. Commission; the conclusions being that the province of each is distinct, and no advantage will result from an attempt on the part of either to invade the other's field). Am Eng & R R Jour-June. 2000 w.

*6311. The Use of Graphical Methods in Keeping the Accounts of Railway Mechanical Departments (An advocacy of the system, with illustration taken from a large western road). Am Eng & R R Jour-June. 900 w.

*6312. Pumps vs. Compressors for Shop Use (An exhibition of the great wastefulness in operation of pumps for this service). Am Eng & R R Jour-June. 1200 w.

*6313. A Substantial Indicator Rigging for Locomotives (Description and illustration of the Penna. R. R. rig, important on account of increasing use of indicator on locomotives). Am Eng & R R Jour-June. 800 w.

6319. The Outlook for Rapid Transit in New York City (Editorial review of the peculiar difficulties and an argument for the tunnel scheme). Eng News-May 28. 2200 w.

6320. The Hardie Compressed Air Motor for Street Cars (A descriptive account with some results of tests). R R Gaz-May 29. 1200 w.

6321. National Convention of Railroad Commissioners (A condensed report of the Washington meeting. The papers and discussions are devoted to various phases of the relation of railroads to the public and to the government). R R Gaz-May 29. 4800 w.

6322. Plan for Removing Grade Crossings in Newark, N. J. (A descriptive account, with plan and profile). R R Gaz-May 29. 900 w.

6323. Rapid Transit in New York (An edit-

orial review in the light of the court's decision against the plan of the commission. The solution favored is a development of the elevated system). R R Gaz-May 29 3500 w.

*6328. Vibration Meters (Description of a seismograph especially adapted to railroad locomotives and vehicles. It is claimed that greatly increased economy and safety will result from study of its cards and correction of the defects thereby discovered). Engng-May 22. 1600 w.

6331. Locomotive Rating and Fuel. Tracy Lyon (Abstract of a paper read before the Western R'way Club. An exposition of the latest practice with an account of the very practical method employed on the Chicago Great Western R'way). Ry Rev-May 30. 2700 w.

6332. New Eight-Wheel Passenger Locomotive. C. R. I. & P. Railway (The engine is designed to give equal service with ten-wheeled engines, with greater economy. Descriptive account with diagrams giving principal dimensions, and drawings of some details). Ry Rev-May 30. 1000 w.

6333. Decision of the United States Court of Appeals in the Gould-Trojan Coupler Case (Abstract of an opinion reversing the order of the circuit court, which was for an injunction *pendente lite*). Ry Rev-May 30. 3000 w.

6337. Rules Governing Engineers—The System in Force on the Soo Line by Which Engineers Engage Their Own Firemen (The rules are given fully in a copy of the letter addressed by the mechanical superintendent to each engineer in the company's service). Ry Age-May 30. 1800 w.

*6338. New Erie Passenger Engine (A description with photograph and sectional drawings. The engine has some novel features in frames and size of steam parts). Loc Engng-June. 500 w.

*6339. An Automatically Closing Steam Fountain that Will Close. John A. Hill (Drawings and description of a device to lessen danger to enginemen from escaping steam. The invention is not patented, but given to the public). Loc Engng-June. 1200 w.

*6340. Southern Railway Air-Brake Instruction Car No. 108 (Brief account with excellent illustrations of an interesting development of modern railroad educational work). Loc Engng-June. 800 w.

*6341. New York, New Haven & Hartford 60,000-pound Coal Cars (The article is illustrated by dimension drawings, and notes some improvements in construction designed to meet the severe strain endured by large cars). Loc Engng-June. 800 w.

*6342. How Cars Are Cleaned by the Wagner Palace Car Co. (The account is designed to show how fully important sanitary requirements are complied with). Loc Engng-June. 700 w.

*6343. Extended Front Ends (A symposium of correspondence, tending to show that the device was a gradual development for which individual credit would be hard to apportion. With editorial). Loc Engng-June. 2200 w.

*6374. The Rouen Electric Tramways. Ill. (Discussing the leading features and characteristics of the work from a critical or comparative standpoint). Elec Rev, Lond-May 22. 3000 w.

†6423. The Future of Electricity in Railroad Work. Dr. Louis Duncan (A lecture delivered before the Franklin Institute A very full and able discussion of the case in all its relations. Electricity is regarded as specially adapted at present to suburban travel, and short feeder lines, but destined to supplant steam, first for through passenger travel; lastly, and perhaps doubtfully, for through freight). Jour Fr Inst-June. 5800 w.

6434. The Bergen County Traction Company's System (Illustrated description of the new road from Pleasant Valley to Englewood, N. J). Elec Eng-June 3. 1800 w.

6439. The Form of the Exhaust Jet in Locomotives. J. F. Deems (Abstract of a paper read before the Western Railway Club. A recital of recent experiences as a member of a committee on proper height, form and arrangement of exhaust jets). Eng News-June 4. 2100 w.

6444. The Joint Traffic Association Sustained (Substance of Judge Wheeler's decision, denying the Government's motion for an injunction. With editorial). R R Gaz-June 5. 2500 w.

6445. Railroad Legislation in New York State (Summary of bills affecting railroad interests passed by the N. Y. legislature in 1896). R R Gaz-June 5. 1000 w.

6447. Performance of the Purdue Locomotive "Schenectady." W. F. M Goss (Read at meeting of W. Ry. Club. A full reprint. The tests bring out some very interesting relations of speed to power and are summarized in an argument for large drivers). R R Gaz-June 5. 2700 w.

*6452. Railway Construction in Asia Minor (A review of the present status, with explanatory comment on the rise of continental and decline of British interest and influence). Trans-May 29. 1300 w.

*6453. The Railways of Cape Colony and Natal (A brief descriptive and financial review for 1895). Trans-May 29. 1400 w.

*6462. The South-Eastern Railway and Its London Traffic (A vivid description of a traffic which has outgrown its facilities. Illustrated by diagram showing "stringing" of the card between 8 a. m. and noon). Engng-May 29. 1100 w.

*6472. A Method of Estimating the Probable Volume of Traffic on New Railways (W. H. Schuermann (A discussion and illustration of Richard and Mackensen's method as applied to American railways, accompanied by tables, formulæ and graphic diagrams). Eng Assn of the South-April. 5000 w.

6480. The Organization of the Chief Engineer's Department of an Extensive Railway. Walter Katte (Deals with the functions of the engineer and the apportionment of members and duties in the various departments of construction and maintenance work). Ry Rev-June 6. 1900 w.

SCIENTIFIC MISCELLANY

Bacteria in Milk.

PROFESSOR H. W. CONN, of Wesleyan University,—a distinguished biologist,—points out the sources of contamination of milk in the *Spatula* (reprinted in *Scientific American*, May 2). Pure milk secreted by a healthy cow contains no bacteria, and, as long as bacteria are perfectly excluded, it remains sweet, suffering none of the ordinary changes, except the natural separation of the cream from the heavier liquid portion. The problem of excluding injurious bacteria, or of destroying them after they have gained access to milk, is the fundamental one in the great milk and dairy industries of the world.

If only healthy cows are milked, how and whence do the bacteria get into milk. Professor Conn says that by the time the milking of a cow is completed the milk will contain a large population of bacteria, but only a very few of these are from the surrounding air. "Part of them are already in the milk pail. The dairyman never washes his milk pail free from bacteria. Even with the most thorough washing which the pails receive on the ordinary farm, the bacteria are not killed, but remain alive, adhering to the cracks in the tin, or in the crevices in the wood. Part of them come from the milker, for he commonly goes to the milking without any special toilet, with his hands not clean, and clothed in the ordinary farm clothes, which have become filled with bacteria from numerous sources. But by far the greatest number come from the cow herself. These are not, however, from the interior of the cow, but from her exterior. First, her flanks are always covered with dirt. Frequently they are covered with layers of dried manure, and always the hair of the legs, sides, flanks, and tail are covered with a large amount of dust and dirt. All of the dirt and manure is crowded with innumerable hosts of bacteria. Again, the milk ducts of the cow's teats form a prolific breeding-place for the bacteria. After each milking, some milk is left in the milk ducts, and in this the bacteria which may get to teat from the air or the dirt or hairs of the cow find abundant food. Here they multiply, and by the time of the next milking they are present in countless millions, ready to be washed out with the first milk that is drawn."

It becomes evident that cleanliness is a virtue of high rank in all that pertains to the treatment of milk as a commercial product. The milk as first obtained is not only one of the most nutritive substances for the growth of bacteria, but its temperature is almost that of the blood of the animal, and as nearly as possible such as promote the rapid growth and multiplication of these destructive agents. Hence is apparent the value of rapid cooling as soon as the milk is obtained and filtered. No practical method of filtering will remove the bacteria, but "immediate and rapid cooling so greatly checks the growth of bacteria as to greatly reduce the number present in the course of twenty-four hours. This is the explanation of the fact that the milk dealer not infrequently has complaints from his patrons that his morning's milk sours, while no such complaints are received of the milk of the night before. The latter was cooled during the night, while the former was taken to delivery at once from the cow or with insufficient cooling. For this reason it actually sours quicker than the milk of the night before, which needs to warm up before the bacteria can grow in it rapidly."

There are more than one hundred species of bacteria which infest milk. "Some of them sour it by changing the milk sugar to lactic acid. This, as well known, is the most common effect arising in milk upon standing, but others produce other results. Some of them make the milk bitter; some curdle it, but render it alkaline or sweet to taste; others give it an unpleasant, tainted taste; others, again, render it slimy

or ropy; some turn it blue or yellow or red."

The presence of some kinds of these bacteria is beneficial. The "ripening" of cream is one of the benefits. "This ripening is nothing more than a fermentation due to the growth of the bacteria which are in the cream. During this twenty-four to forty-eight hours the bacteria which were in the cream multiply rapidly. This growth produces a fermentation, just as the growth of yeast in the brewery malt produces its fermentation.

"The object of this ripening is at least threefold. First, it makes the cream churn more readily, and, second, it gives a larger amount of butter from a given lot of cream. The third object is to give flavor to the butter." These changes result from chemical changes effected by the presence of bacteria, the first products being agreeable to taste and smell; but, if the action be too long continued, unpleasant flavors are produced, and the latter may also be produced in milk almost fresh from the cow by the presence of deleterious bacteria. The ripening of cheese also results from bacteria present in it, and the different flavors of the different varieties of cheese result from the action of different kinds of bacteria under conditions of temperature, light, and exposure to air favoring the growth of one species more than another, in a manner precisely analogous to the growth of different kinds of ferments in the wort of beer in brewing, by which different flavors in malt liquors are produced during the fermentation.

The New Process for the Liquefaction of Gases.

To what purposes liquefied air may be applied in the arts is yet undetermined. One purpose, however, we venture to suggest, may be its use in pneumatic guns for projecting dynamite shells. A pound of liquefied air occupies only a few cubic inches of space, and in this state, by absorption of heat from its surroundings, it can store up a very large expansive energy. This energy is represented in terms of work by its increase in volume during the resumption of its gaseous condition against the external pressure of the atmosphere plus the energy inherent in one pound of gaseous air under ordinary conditions, expressed also in terms of work. At normal pressure and temperature the volume of one pound of gasified air is about thirteen

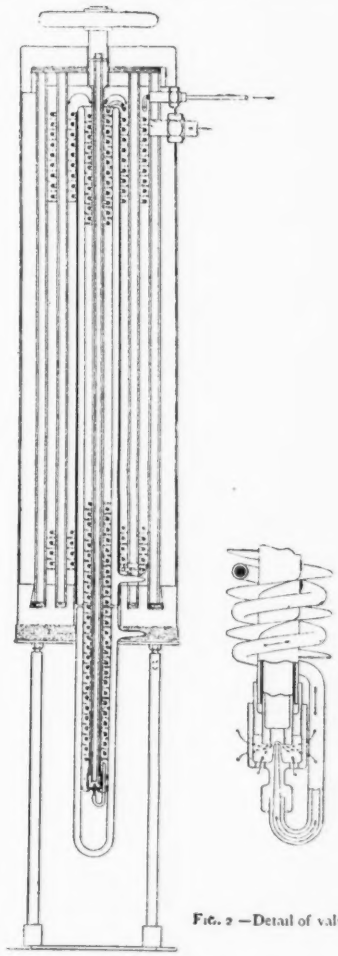


FIG. 2.—Detail of valve

FIG. 1.—Sectional elevation

cubic feet. A small weight of liquefied air placed in an evaporator of minute dimensions could soon be made to generate a large volume of gaseous air under a pressure of, say, one thousand pounds per square inch, which is not far from the

pressure used in pneumatic guns; and the only limitation to pressure is mechanical and practical, — to wit, tight fitting of joints, etc., to prevent leakage.

Pertinent to this question of utility is a description of Dr. William Hampson's new apparatus for liquefying gases, condensed from *Nature* (April 2).

The apparatus consists of three coils of narrow copper tubing, arranged concentrically in a metal case, and connected successively together, as in Fig. 1,—a vertical section of the apparatus. The gas, say oxygen, enters the coil, which is surrounded by a cylindrical-glass vacuum-jacketed vessel, as devised by Prof. Dewar. The two outer coils are separated from each other by vertical divisions of the case, and the spiral of the central coil is followed by a flat spiral of sheet copper. When the gas reaches the extremity of the central coil, it escapes through a fine orifice of peculiar construction, formed by bringing two knife-edges closely together (shown in Fig. 2). The size of the orifice can be regulated by means of an ebonite rod, which passes up the axis of the apparatus, and terminates in a handle at the top. After its escape, the whole of the gas cooled by expansion passes through the spaces surrounding the pipe through which the compressed gas is passing to the point of expansion, and so makes this gas, still under pressure, cooler than it was itself while under compression. The compressed gas consequently becomes at the point of expansion cooler than that which preceded it, and in its turn follows backwards the course of the still compressed gas, and so makes the latter cooler than before expansion, and therefore also cooler than ever after expansion. This intensification of cooling (always assuming sufficient protection against access of heat from the outside) is limited only by the liquefaction of the gas,—the temperature of liquefaction being, in the case of oxygen, — 180°C.

The apparatus is only twenty-eight inches high, and seven inches in diameter, and yields seven cubic centimeters of liquefied oxygen in four minutes. No other artificial cooling agent, inside or outside, is needed. It is expected that by this apparatus, which may, of course, be made of much larger capacity,—it being merely a working model,—the liquefaction and, perhaps, the subsequent solidification of hydrogen will be achieved, and thus enable an exact study in the liquid and solid state of this important elementary substance to be made.

The attainment of the absolute zero is not far away from the low temperatures now obtained; and it is not improbable that the study of matter at the absolute zero of temperature may be possible before the end of the present century.

Admission Requirements of Engineering Schools.

As a side-light on the current discussion of the value and methods of modern engineering and technical schools, a letter to *American Machinist* (June 4) is extremely interesting. Mr. William O. Webber having asked, in the columns of the paper named, where "the ideal school, turning out good foremen, superintendents, chief engineers, and professional men can be found." Mr. Mark Talcott, the correspondent referred to, thinks the question can be at least partially answered by a table of occupations in which post-graduates of Worcester Polytechnic Institute are now engaged; and he presents the table accompanying this review.

He explains that the table is a "*résume* of the entire graduate body for the years 1871 to 1895, inclusive, embracing a total of 650 men in fourteen classified occupations, the figures in the body of the table giving the percentage (based on the total membership of each class) of its members in each occupation. The number of men on which the percentages in each case are based is found at the foot of the column bearing the year of the class graduation.

"Of the 650 men recorded, but 4 per cent., or 26 men, are not engaged actively in lines of work for which the Institute course specially prepared them. Of the remaining 164 men in unclassified occupations, marked 'Others,' it may be said that the catalogue of the Institute does not give with sufficient clearness the occu-

pations of these, though they may in general be classified with the others; and this classification is in no way an indication that they are not in active service in some of the lines that are mentioned. A reference to the table will show at a glance that the largest proportion of the men get into business for themselves. This is especially true of the older classes. The next grade may be named as the 'managers in business,' and in this grade, as well, the older classes are largely represented. 'Superintendents,' 'mechanical engineers,' and 'assistant engineers' are also well filled out with older classmen. The positions of 'draftsmen,' 'professors and instructors,'

Occupation.	Year of Graduation.																							Total for Each Grade.
	1871.	1872.	1873.	1874.	1875.	1876.	1877.	1878.	1879.	1880.	1881.	1882.	1883.	1884.	1885.	1886.	1887.	1888.	1889.	1890.	1891.	1892.	1893.	1894.	1895.	
Partner in business.	37	50	16	23	62	35	23	29	35	7	29	32	28	37	16	31	23	21	9	6	9	..	..	2	2	119
Manager in business	..	..	16	7	6	10	5	17	10	14	6	11	..	13	15	7	6	..	..	6	6	3	6	..	..	37
Superintendent	6	..	8	8	6	..	..	5	..	7	23	11	6	13	16	10	..	3	6	..	..	3	2	3	2	32
Mechanical Engineers	6	..	12	..	..	6	5	..	5	..	..	..	..	11	..	4	3	7	..	..	12	3	3	6	2	22
Assistant C. E. and M. E	12	6	6	8	..	23	24	6	10	21	12	3	..	8	4	7	10	9	..	12	6	9	2	9	..	48
Assistant Superintendent	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	6	..	..	3	2	3	2	6
Draftsmen	..	..	6	..	..	6	5	12	5	..	6	11	17	8	..	3	..	12	16	12	9	21	12	13	28	63
Professors and Instructors	6	12	6	15	..	12	5	..	10	7	..	6	11	4	8	17	23	18	12	12	10	3	7	13	3	01
Chief Engineer	..	..	..	..	..	..	..	..	..	..	..	7	..	4	..	..	..	3	..	..	..	..	..	..	..	4
Master Mechanic	6	6	..	..	..	..	..	..	..	..	..	..	..	4	..	..	..	3	..	..	..	..	..	..	..	4
Chemists	..	..	..	..	..	..	..	6	..	..	6	..	..	..	..	..	3	9	..	9	6	6	8	..	7	20
Electricians	..	..	..	..	..	..	..	..	..	7	..	4	..	..	..	..	..	..	18	6	3	3	5	3	..	17
Examiner, U. S. Patent Office	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	10	..	6	..	3	12	6	..	..	13
Assistant Manager	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	3	..	..	2	..	..	2
Others	21	26	30	39	26	8	28	25	25	37	18	18	27	9	37	22	18	22	27	21	42	32	42	52	56	190
Total in each class.	16	16	16	13	16	17	21	17	20	14	17	28	18	24	25	29	30	33	33	33	31	32	49	47	47	650

NOTE—The figures in the body of the table give the *percentage* based on the number in each class of its members in each occupation.

'chemists,' 'electricians,' and others are more fully occupied by the more recent graduates; and also, the proportion of the unclassified is far greater in the recently-graduated classes. The logic of the table would therefore seem to be that the more responsible positions are gained after years of service, to which the Institute training is merely the foundation, and in no way a part of the superstructure. At this juncture it is pertinent to point out, therefore, that no institution, however thorough or severe its course of instruction and training, can be supposed to turn out anything,—foremen, superintendents, or anything else. It simply turns loose a lot of raw material, from which, later on, these various grades of engineers may develop."

Mr. Talcott will not be displeased, we think, at an amendment which we propose to his last proposition. In many senses the material turned out by the technical schools is raw; it needs a good many processes before it can become the widely-demanded, finished, merchantable article; but, if it has not been materially advanced from original crudity, a reason for the existence of the schools is not apparent. It is necessary to show (and it can doubtless be shown) that the positions that these graduates now hold were attained in a sufficiently shorter time from their matriculation, and that their efficiency in their several professions or occupations has been sufficiently enhanced, to repay the expense of time and money entailed by the courses of study pursued. We repeat that we have no doubt that this could be proved, and therefore we would not use the unmodified term "*raw material*" as applied to the graduates of engineering schools. We prefer the term "*prepared*," or "*improved*," raw material.

Discharge of Rivers as Influenced by Forest Removal.

IT is a commonly-received opinion that the flow of streams and also climatic conditions are permanently influenced by the removal of forests. Mr. Dwight Porter, of the Massachusetts Institute of Technology, has been testing the accuracy of

this belief, so far as observations upon flow in the Connecticut river throw light upon it; and he gave results in a paper read last year before the American Forestry Association.

This river was selected among the very few streams upon which reliable and long-continued observations have been made, and upon whose upper drainage area the clearing of forests has been going on for many years. From this paper, in *Science* (April 17), it appears that no permanent change of flow can be predicated, as indicated in the records from 1841 to 1895.

"The theory as to the effect of forests is that, by shading the ground, they tend to prolong the melting of snow in the spring, and thus to prevent excessive freshets, as well as to maintain the naturally-decreasing flow of late spring and early summer. Further, by reducing the evaporation from the ground, by obstructing the free flow of surface water after rains, as well as by conserving the snows, they tend to maintain a large volume of ground water, which, issuing in visible springs or in invisible seepage, must of course be the reliance of all streams in dry weather. The effect of extensive forest-cutting might, therefore, be expected to be an increase in the number, suddenness, and height of oscillations, and, on the other hand, a more speedy falling away in summer, and a lower range of dry-weather flow."

Professor Porter admits, however, that records of flow for longer periods than are available are needed to positively determine the effect of forest-cutting upon streams. He also notes that such effects upon the Connecticut river should be most evident for the past twenty-five years in the upper river; but the only records available are those made at Hartford and Holyoke.

"At Hartford the tributary area is about 10,200 square miles, and for a period of over fifty years records are available of the maximum freshet height of each year. Further, observations to determine the daily rate of discharge were begun in 1871 by General Theodore G. Ellis, and were continued without interruption until 1886, although for 1882 and 1883 the figures are not at hand. There was thus obtained a record having few parallels in this country, and it is deeply to be regretted that the United States engineers should have permitted it to be discontinued, as was done in 1886. At Holyoke, where the drainage area is about 8,000 square miles, the Holyoke Water Power Company has maintained since 1880 a daily record of the discharge of the river past that point, which record is still continued, and is on the whole the most valuable that now exists regarding the discharge of this stream."

Averaging these records, both for freshet height and for low-water flow, no indications of permanent change are found in either. Tables of heights and of flow, with a diagrammatic representation of the same, are presented, and confirm the opinion, "The highest freshet was in 1854, the lowest in 1858, and only twice has the height of 27.7 feet, attained in 1801, been exceeded. Apparently there was a gradual increase in the *average* height down to 1880, while at the same time there was a marked and steady decrease from 1854 to 1880 in the heights of the more extreme freshets."

Source of the X Rays.

IN notes of observations on the Röntgen rays, Professors Henry A. Rowland and L. J. Briggs, in *The American Journal of Science* for March, announce their opinion that the source of the rays seems to be more connected with the anode than the cathode.

In making the above announcement, the writers state that they have been unable to obtain any trace of reflection from a steel mirror at a large angle of incidence,—an effect noted by Röntgen,—but, in their experiments, the mirror was on the side of the photographic plate next to the source of rays, while in Röntgen's method the mirror was placed behind the plate.

In a subsequent communication to the *Electrical World*, the authors express a modification of the view above stated. They still think the anode or its equiva-

lent is the main source of the X-rays, yet they now say they have evidence that in some of the tubes it is necessary that the cathode rays shall fall on the anode in order that the Röntgen rays may be formed.

THE ENGINEERING INDEX—1896.

Current Leading Articles on Various Scientific and Industrial Subjects in the American, English and British Colonial Scientific and Engineering Journals—See Introductory.

†5780. Natural Science in a Literary Education. Albert H. Tolman (In the present state of the educational question, the opinions and arguments contained in this attempt to show what ought to be the attitude toward science, of those students who wish a literary education, will be read with interest). Pop Sci M–May. 2300 w.

†5781. Recent Work on the X-Rays (A general résumé of progress compiled from many sources, largely from the technical periodicals of Europe and America). Pop Sci M–May. 3000 w.

5787.—75 cts. Calorimetry. Methods of Correction for Cooling. Silas W. Holman (A general method of treating the cooling correction which is applicable to nearly all non-continuous calorimetric processes, such as the measurement of specific heats by the "method of mixture" of heat of combustion by the Berthelot or Mahler bomb, etc. It is reliable in ordinary practice within the limits of error imposed by the thermometry and by irregularity of conditions as to surroundings. The paper claims the attention of those who desire a concise working statement of a method of cooling correction which has stood the test of practice). Tech Quar–Dec. 2500 w.

5788.—75 cts. Thermo-Electric Interpolation Formulæ. Silas W. Holman (In this paper are collected the several well-known types of formulæ for expressing the thermal electro-motive force of a couple as a function of the temperature of its junctions. Two new formulæ are also proposed. All then are tested against the most reliable, experimental data upon the subject, and their relative merits discussed). Tech Quar–Dec. 5500 w.

*5803. The Production of Caustic Soda and Bleach by Electrolysis (Editorial discussion of the Holland process, which is pronounced a marked improvement over all hitherto existing processes, and destined to effect a notable reduction in the cost of caustic soda). Engng–April 24. 1800 w.

†5821. A Simple Method for Determining the Neutrality of the Ammonium Citrate Solution Used in the Analysis of Fertilizers. N. W. Lord (A method which has been used in the writer's laboratory and has proved rapid and exact. The details of the method are given). Jour Am Chem Soc–May. 450 w.

*5844. Steel Storage Tanks for Grain (Illustrates and describes structures of this kind in use at the Manhattan mill, Toledo, Ohio). Am Miller–May 1. 1100 w.

*5845. Relation of Color to Value in Flour. (A recent lecture before a bread-making class at Salisbury, England, describing a new method whereby color of flour can be made to indicate its quality, and stating the significance of different tints and shades, determined by scientific investigation). Am Miller–May 1. 1700 w.

*5849. The Röntgen Rays. J. J. Thomson (Some remarks on the investigations of M. Henri Becquerel interesting on account of the differences as well as the analogies disclosed between uranium radiation and the Röntgen rays, followed by review of late experiments and progress). Nature–April 23. 2200 w.

*5850. On a New Form of Radiation. Wilhelm Konrad Röntgen (Second communication of the writer's investigations, giving some new results). Elect'n–April 24. 2000 w.

*5851. Discharge Phenomena in Rarefied Metallic Vapors. E. Wiedemann and G. C. Schmidt (An account of experiments with metallic vapors showing (1) that in a heated conducting glass bulb, rarefied metallic vapors may be made to glow by oscillating discharges. (2) In metallic vapors the typical discharge phenomena occur, even in monatomic ones. Color and spectrum of the first and third glow-light strata and of the positive light are essentially different). Elect'n–April 24. 1200 w.

*5852. On a Crookes Apparatus. H. Pfloum, in *Wied. Ann* (Description of the behavior of a 7 B bulb). Elect'n–April 24. 800 w.

*5853. On the Effect of the Röntgen X-Rays on the Contact Electricity of Metals. James R. Erskine Murray (The experiments described were made in the Cavendish Laboratory of the University of Cambridge, at Prof. J. J. Thomson's suggestion, in order to find whether the contact potential of a pair of plates of different metals is in any way affected by the passage of the Röntgen X-Rays between the plates). Elect'n–April 24. 1200 w.

*5854. On the Behavior of Argon and Helcum When Submitted to the Electric Discharge. i. N. Collie and William Ramsay (Experiments Jarried out more with a view of obtaining practical help in recognizing the purity of argon and helium than of carrying out a research on the relative conductivities of gases). Elect'n–April 24. 1800 w.

*5857. Sixty-Eight Octaves. T. H. Muras (Table showing, on a uniform scale, the relations of the different kinds of vibrations now known). Elec Rev, Lond–April 24. 250 w.

5863. Theory of Burning Clay Ware. Max A. Th. Boehncke (A review of some things necessary for the successful burner of clay to know). Brick–May. 3000 w.

5867. On the Reflection of Röntgen Rays.

We supply copies of these articles. See introductory.

O. N. Rood (Abstract of paper read before the National Academy of Science. Experiments claiming to demonstrate the regular or specular reflection of the Röntgen rays). Elec Wld–May 9. 600 w.

†5887. A Classification and Catalogue System for an Engineering Library. F. R. Hutton (Read before the A. S. M. E. General discussion of library cataloguing, and an attempt to evolve a good system for engineering libraries). Trans Am Inst of Mech Engs–Vol. XVII. 3800 w.

5901. Rice Culture in Southwestern Louisiana. H. H. Childers (Illustrated popular description). Sci Am–May 9. 1200 w.

5933. The Cyclotomic Transit (Illustrated description of a new transit with only one central spindle, turning within the leveling head, and in which the azimuth circle plate is made a part of the rigid substructure. Correlated with this is a floating ring upon which the figures representing degrees are marked, so that instead of turning the whole plate, only the floating ring is in use, turned around the central vertical axis) Eng & Min Jour–May 9. 900 w.

†5935. Artificial Legs and Arms of Rubber. Gustav Heinsohn (Historical account of the use of rubber in this effort to contribute to the comfort of man, with illustrated d scription of some late work). Ind Rub Wld–May 10. 2c00 w.

†5936. Shoe Lasts and Boot-Trees for Rubber Footwear (An account of the different substances used for this purpose, with reference to the expense to the trade from the necessity of the many styles, and the effect of heat, &c , on the various materials from which they are made). Ind Rub Wld–May 10. 2500 w.

5937. The Rubber Situation in Madagascar (Brief description of the growth of rubber yielding plants, with account of the practice of the native rubber-gatherers, and the prediction that the industry is destined to become more important). Ind Rub Wld–May 10. 1300 w.

*5945. Quackery in Engineering Education. Edward H. Williams, Jr., D. C. Jackson, H. K. Landis, and George L. Hoxie (A symposium suggested by Prof. Kidwell's article on the same subject). Eng Mag–June. 4200 w.

5950. Note on a Breathing Gas Well. Harold W. Fairbanks (Brief description and remarks upon a well situated on the Eagle Ranch, in San Luis Obispo Co., California, which gives an intermittent flow of natural gas). Science–May 8. 900 w.

5951. Source of X-Rays. A. A. Michelson and S. W. Stratton (Illustrated description of experiments which appear to prove that in a vacuum tube, of a form specified, the X-rays radiate in all directions from the surface first encountered by the cathode rays). Science–May 8. 500 w.

5952. The Color of Water, as Affected by Convectional Currents (Review of an interesting study by Prof. W. Spring, of Liège, of the causes that impart color to water in masses). Science–May 8. 600 w.

5953. The Plasticity of Ice Crystals (Brief review of an experimental study by Dr. O. Mudge, which shows that the bending of ice, acts in the direction of its optic axis, and that plastic translation without bending is only possible in a plane perpendicular to the optic axis). Science–May 8. 300 w.

5954. On Rood's Demonstration of the Regular or Specular Reflection of the Röntgen Rays by a Platinum Mirror. Alfred M. Meyer (A criticism upon Dr. M. I. Pupin's criticism of Prof. Rood's account of experiments, wherein the latter says the results point to the conclusion that in the act of reflection from a metallic surface, the Röntgen rays behaved like ordinary light. Dr. Pupin having denied the fact of regular or specular reflection in Prof. Rood's experiments, Prof. Meyer says, that after a careful examination of Prof. Rood's negatives, he thinks regular and specular reflection of the x-rays are demonstrated facts). Science–May 8. 600 w.

5955. Pseudo-Science in Meteorology. B. E. Fernow (A warning against erroneous observations, and fallacious conclusions, relating to effects of forest removal upon water-flow, and upon meteorological phenomena, especially on water-flow in the western mountains). Science–May 8. 1600 w.

†5993. The Proposed Gigantic Model of the Earth. Alfred R. Wallace (A criticism of the recently elaborated scheme of M. Elisée Reclus, for the construction of a gigantic model of the earth—418-ft. in diameter—and a description of a substitute, considered by the author as possessing far greater advantages, and which would cost much less to construct). Contemporary Rev–May. 4500 w.

*6018. Recent Researches on the Röntgen Rays. M. Guillaume in *La Nature* (The writer states that investigations are being extended in three distinct directions. In the first place, attempts are being made to discover the properties of the new rays; second, apparatus for producing and utilizing them are being perfected; lastly, investigations as to the source of the different rays of the vacuum tube. Experiments are discussed and illustrated). Elec Rev, Lond–May 1. 2200 w.

*6024. Recent Work with Röntgen Rays (Notes on papers and communications received during the last few days previous to date, and supplementary to J. J. Thomson's article in last number of same paper). Nature–April 30. 5500 w.

*6025. Color Photography. Prof. Lippmann (Read before the Royal Society. Description and demonstration of researches in color photography). Nature–April 30. 2800 w.

†6027. Solids and Vapors. Wilder D. Bancroft (An interesting study of the phenomena of deliquescence and efflorescence, showing that these phenomena are influenced by variable conditions of temperature and vapor tension, and stating the conditions under which crystals of anhydrous and hydrated salts will be permanent or otherwise. All the conclusions are concisely stated at the end of this able paper). Phys Rev–May-June. 6000 w.

†6028. On the Heat Effect of Mixing Liquids. C. E. Linebarger (An experimental research.

Details of experiments are presented, and the results are given in tabulated form). Phys Rev-May-June. 5000 w.

†6029. The Influence of Heat, of the Electric Current, and of Magnetization upon Young's Modulus. Mary Chilton Noyes (Describes methods, apparatus and experiments directed to distinguish between the effects upon Young's modulus due to heat, to the longitudinal magnetization and the electric current through a wire, and instituted to investigate certain unexplained and irregular results in a previous set of experiments in which an electric current was used as a source of heat, in determining the effect of temperature upon this modulus for a piano wire. The results are illustrated by diagrams and afterward presented in tabulated form). Phys Rev-May-June. 4500 w.

†6030. A Method for the Use of Standard Candles in Photometry. Clayton H. Sharp (This study of photometry is based upon the proposition that in a photometric test the rate of consumption at the instant at which a photometer setting is made ought to be known; but, as this is impracticable, a series of experiments for the investigation of the relation between flame height and intensity, and to determine whether such a relation would not enable more consistent results to be obtained than by the method of correcting for rate of consumption, is described, illustrated by diagrams and the results tabulated). Phys Rev-May-June. 2500 w.

†6031. The Graphical Representation of Magnetic Theories. Harold N. Allen (The object of the paper is to insist on the distinction between Faraday's theory of magnetism, and the older theory—which assumes the existence of magnetic fluids covering the ends of the magnet—still often made use of, because mathematically simpler, and at the same time to consider some points in the induction theory itself. Different aspects of the theory are illustrated by diagrams, and the discussion is on mathematical as well as physical lines). Phys Rev-May June. 2000 w.

6037. On Apparatus for Cathography. Nikola Tesla (The writer has found that the most suitable apparatus, and one which secures the quickest action, is a disruptive coil. Directions are given for use). Min & Sci Pr-May 9. 1400 w.

6041. The Source of Röntgen Rays. Ill. Alexander Macfarlane (Further experiments on the source of Röntgen rays, from which cathode rays appear to be due to radiant matter, while Röntgen rays appear to be light waves too short to lie within the range of vision). Elec Wld-May 16. 700 w.

6059. Behavior of Sugar toward Röntgen Rays. Ferdinand G. Wiechmann (Tests made by the writer, showing that amorphous sugar is more transparent to the X-rays than the crystalline). Science-May 15. 700 w.

6060. The X-Rays in Medicine and Surgery. Charles L. Norton (The application of X-rays to the diagnosis of disease. Tests that make it seem that a very wide field is open to medical as well as surgical investigations). Science-May 15. 550 w.

6063. Manufacture of Calcium Carbide. Orrin E. Dunlap (Illustrated description of the plant at Niagara Falls). W Elec-May 16. 2000 w.

†6082. Corn Oil. Harry W. Allen (An investigation of the physical and chemical properties of corn-oil now used as an adulterant, but which is produced in large quantities, and if practical uses could be found might become a more important article of commerce). Engineers' Year Book-Univ of Minn. 1200 w.

*6090. High Explosives and Smokeless Powders. Hudson Maxim (Deals with the effects of high explosives as destructive agents of warfare, with diagrams illustrating these effects, the qualities required in a good smokeless powder of high explosive character, and describes the Maxim powder, with tables of results attained in government experiments with guns of various calibers, at Sandy Hook. Discussion). Jour Soc of Arts-May 8. 5700 w.

6118. How Belleek Ware Is Made (An interesting description of this celebrated porcelain). Clay Rec-May 14. 1000 w.

6119. How Terra Cotta Is Made. From the *New York Times* (Interesting description of process, with remarks on the durability, extensive use, raw material, etc). Clay Rec-May 14. 2700 w.

6175. Photography in Vacuo. Joseph Cottier (Notes intended to throw light on this subject. The bulk of evidence is to the effect that a sensitive plate retains its impressibility after removal of the air). Elec Wld-May 23. 1600 w.

6177. Roentgen Rays. Philip Mills Jones (Considers the source and nature of the rays and their possible usefulness). Min & Sci Pr-May 16. 2500 w.

6179. Artificial Flight Successfully Achieved by Prof. Langley's Aerodrome (Letter from Alexander Graham Bell, with explanations by Prof. Langley, describing briefly a trial of this machine and its successful operation). Sci Am-May 23. 800 w.

6180. Modified Milk (An illustrated description of scientific preparation of milk for food). Sci Am-May 23. 1600 w.

6197. The Embankments of the River Po. Frank D. Adams (Interesting facts relating to this embankment and the rapid advance of the sea upon the shores of Lombardy and adjacent shores of the Adriatic). Science-May 22. 1500 w.

*6221. Experimental Error (Editorial review of A. B. W. Kennedy's "James Forrest lecture" on Physical Experiment in Relation to Engineering). Engng-May 15. 1600 w.

*6222. Physical Experiment in Relation to Engineering. Alexander Blackie William Kennedy (The "James Forrest" lecture delivered at the Inst. of Civ. Engs. Physical experiment is regarded not only as an essential part of engineering work, but as an important aid to engineering instruction). Engng-May 15. 7500 w.

*6245. Fabrics. Aldam Heaton (Paper read before the British Arch. Assn. Pointing out the nature of the most useful fibres and the characteristics of the fabrics produced from them). Arch, Lond-May 15. 7200 w.

6280. Latest Inventions in Aerial Navigation. Rudolph Kosch (Illustrated description of a new experimental machine, designed by the author, and some results attained by it, with general remarks upon aviation). Sci Am Sup-May 30. 2800 w.

6287. On a Rotational Motion of the Cathode Disk in the Crookes Tube. Francis E. Nipher (Read before the Academy of Science of St. Louis. An account of an observation made in the use of the Crookes tube and subsequent experiments). Elec Rev-May 27. 800 w.

6299. Some Experiments with Röntgen Rays. W. C. Peckham (Successful experiments made with the object of dispensing with the fluoroscope and its use by individuals, and to show the effects to an audience, all at once). Elec Wld-May 30. 600 w.

6300. Standards of Light. Edward L. Nichols, Clayton H. Sharp, and Charles P. Matthews (Abstract of a preliminary report of the Sub-Committee of the Amer. Inst. of Elec. Engs). Elec Wld-May 30. 1000 w.

†6314. How the Great Lakes Were Built. J. W. Spencer (A geological study). Pop Sci M-June. 4800 w.

†6315. The Metric System. Herbert Spencer.—With a Letter from Sir Frederick Bramwell (An argument against the adoption of the metric system, claiming that it does not fulfill the requirements of scientific and ideal perfection). Pop Sci M-June. 7800 w.

†6351. Concerning Crookes Tubes. C. C. Hutchins and F. C. Robinson (An article proving that the making of these tubes need not be beyond the resources of the ordinary laboratory. A little skill in glass-blowing and in the manipulation of the pump is all that is required). Am Jour of Sci-June. 1300 w.

†6352. Researches on the Röntgen Rays. Alfred M. Mayer (Experiments described were made in the private laboratory of Prof. Rood in Columbia University). Am Jour of Sci-June. 3300 w.

6354 Self Education in Gas Engineering. A. C. Humphreys (The misleading idea that special education in gas engineering will not be needed in the future is deprecated, and the lines along which such education must proceed are defined). Am Gas Lgt Jour-June 1. 12000 w.

6355. The (Alleged) Law of Inverse Squares. B. E. Chollar (This law is treated as geometrical, not physical, and its relation to the commercial value of artificial lights is considered. Practical exceptions to the operation of the law are noted. Paper criticised in discussion). Am Gas Lgt Jour-June 1. 10000 w.

6388. Röntgen Rays. D. W. Hering (A descriptive account of the means of producing these rays, and a general statement of the phenomena, with a brief review of the advances made since the first announcement of the discovery). Am Elect'n-May. 1600 w.

6389 Crookes Tubes and Experiments with Röntgen Rays. Thomas Duncan (Suggestions for the making of Crookes tubes for experiments with these rays, and the precautions necessary). Am Elect'n-May. 1500 w.

6390. A Röntgen Ray Outfit (Part first describes the construction of the induction coil, with precautions and methods. Illustrations). Am Elect'n-May. Serial. 1st part. 3000 w.

6417. Seger Cones (What is a seger cone?—Its size and shape; what it is made of; a reliable test for burning that may save hundreds of dollars—The insufficiency of all other methods). Brick-June. 1300 w.

6418. The Measurement of High Temperatures. From *La Genie Civil* (Progress and present status of the art). Sci Am Sup-June 6. 2000 w.

6422. Admission Requirements to Engineering Schools. Mark Talcott (Interesting statement of occupations of post-graduates of Worcester Polytechnic Institute). Am Mach-June 4. 700 w.

†6425. Engineering as Exhibited on the Great Lakes. John Birkinbine (General review of engineering progress in all departments in the lake region). Jour Fr Inst-June. Serial. 1st part. 5300 w.

*6451. The Joule Effect. C. E. Basevi (This phenomenon jointly investigated by Joule and Kelvin in 1852 and 1853, is discussed in its relation to liquefaction of air by the most recent processes, and is held to be inadequate to account for the results attained. A criticism of Joule's and Kelvin's experiments and an explanation of the processes is presented). Eng, Lond-May 29. 3200 w.

*6461. The Sailing Flight of Birds (An attempt to explain the sailing flight of birds by the action of lateral wind). Engng-May 29. 1000 w.

*6477. A New Computing Instrument. W. H. Schuermann (Illustrated description of a new instrument, differing from the ordinary slide-rule by the use of angular instead of rectilinear units) Eng Assn of the South-April. 2400 w.

*6487. Some Experiments with Hittorf Tubes and Röntgen Rays. Antonio Roiti (Experiments made by writer. Treats of shadows and penumbras; the behavior of a tube during exhaustion; shadows directly magnified; fluorescence does not appear to be a necessary condition for the emission of Röntgen rays; complications of phenomena and the necessity for describing minutely all the circumstances in which the observations are made; and applications to petrography). Elect'n-May 29. 3300 w.

†6499. Talks with Rubber-Men on Air-Brake Hose (A consensus of opinions of rubber men). Ind Rub Wld-June 10. 2500 w.

†6500. The Manufacture of Fabrics for Tires (Review of the fabrics used and their wear, with an account of the use of sea island cotton, which is considered the most successful). Ind Rub Wld-June 10. 1700 w.

†6502. Fire-Hose Requirements in New York City (Specifications for hose required by the city, with information regarding kind of hose used in different cities, and cost). Ind Rub Wld-June 10. 1300 w.

BOOKS OF MONTH

Descriptive Circulars containing full information relative to books herein named may be obtained of the publishers.

Burr, S. D. V. Bicycle Repairing. David Williams, New York. 1896. Cloth, $1.

Thorpe, T. May. What is Money? or Popular Remedies for Popular Ills. J. S. Ogilvie Pub. Co. 1896. Paper, 75c.

Frank C. Smith. American and English Corporation Cases. A Collection of Cases Affecting Corporations of Every Kind Other than Railroad and Municipal in United States, Canada and England. E. Thompson Co., Northport, N. Y. 1896. Sheep, $4 50.

Sound Currency 1895. Reform Club Sound Currency Committee. 1895. Paper, $1.

Davis, P. J. Standard, Practical Plumbing. Spon & Chamberlain. 1895–1896. Cloth, Vol. 1, $3; Vol. 2, $4.50.

Ellstaetter, K. The Indian Silver Currency. An Historical and Economic Study. Translated by J. Laurence Laughlin. The University of Chicago Press. 1895. Cloth, $1.25.

Hammel, W. C. A. Observation Blanks in Physics. American Book Co. New York. 1896. Paper, 30c.

Hanson, E. C. Practical Studies in Fermentation, Being Contributions to the Life History of Micro Organisms. Translated by A. K. Miller. Spon & Chamberlain. 1896. Cloth, $5.

Koch, Alex. Editor. Academy Architecture. New Series. Vol. 3. Supplement to Volume for 1895. Bruno Hessling. New York. 1896. Cloth, $2.50.

Kramer, Th, v. and Berehns, W. Ornamental Fragments, Scrolls, etc. Bruno Hessling. New York. 1896. Cloth, $13.50.

Lemoke, Mrs. Gesine. How to Live Well on Twenty-five Cents a Day. J. S. Ogilvie Pub. Co. New York. 1896. Paper, 25c.

Thomas, Thaddeus P. The City Government of Baltimore, Md. The Johns Hopkins Press. Baltimore, Md. 1896. Paper, 25c.

Wilcox, Lute. Irrigation Farming. Orange Judd Co. New York. 1895. Cloth, $1.50.

Cheever, Noah W. Corporation Form Book for the Organization of Private Corporations. Callaghan & Co. Chicago. 1895. Sheep, $3.50.

Callet, Harold. Water Softening and Purification. Spon and Chamberlain. New York. 1896. Cloth, $2.

Del Mar, Alex. History of Monetary Systems. Brentano's. New York. 1895. Cloth, $5.

Dunn, Ja. D. Manual of Geology Treating of the Principles of the Science with Special Reference to American Geological History. American Book Co. 1895. Cloth, $5.

Eissler, M. The Metallurgy of Gold. 4th edition revised and enlarged. D. Van Nostrand Co. 1896. Cloth, $5.

Grimshaw, Robert. Shop Kinks and Machine Shop Chat. Norman W. Henly & Co. New York. 1896. Cloth, $2.50.

Hancock, Herbert. Test-book of Mechanics and Hydrostatics. D. Van Nostrand Co. 1895. Cloth, $1.75.

Howard, M. W. The American Plutocracy. Holland Publishing Co. New York. 1896. Cloth, $1. Paper, 50c.

Hunter, Robert. Editor. The Encyclopædic Dictionary. Syndicate Publishing Company. Phila. 1895. 4 vols. Cloth, $16.

Merriman, Mansfield. Text-book of the Mechanics of Materials. 6th edition revised and enlarged. John Wiley & Sons. 1895. Cloth, $4.

Petrie, W. M., Flinders. Egyptian Decorative Art. G. P. Putnam's Sons, importers. New York. 1895. Cloth, $1.25.

Rickard, T. Arthur. Professional Papers on Mining and Metallurgy read before the American Institute of Mining Engineers. Scientific Publishing Co. New York. 1896. Cloth, $2.

Rockell, Alfred Perkins. Roads and Pavements in France. John Wiley & Sons. 1895. Cloth, $1.25.

Scott, A. G. A Digest of the Mechanics' Lien Law of Illinois, with Forms. S. P. Stansbury & Co. Chicago. 1896. Paper, 25c.

Siebert, J. S., and Biggin, F. C. Modern Stone Cutting and Masonry, with Special Reference to the Making of Working Drawings. John Wiley & Sons. New York. 1896. Cloth, $1.50.

Spears, J. R. The Gold Diggings of Cape Horn. G. P. Putnam's Sons. New York. 1895. Cloth, $1.75.

Bennett, G. C. Paupers, Pauperism and Relief Giving in the United States. G. C. Bennett, New York. 1896. Paper, 15c.

Jamieson, Andrew. A Text-Book on Applied Mechanics. Specially arranged for Engineering Students. J. B. Lippincott Co., Philadelphia. 1896. Cloth, $2.50.

Jordan, C. H. Tabulated Weights of Angles, Tee and Bulb Iron and Steel. Spon and Chamberlain, New York. 1896. Cloth, 75c.

Nystrom, J. W. Pocket-Book of Mechanics and Engineering. 21st edition revised and corrected by Robert Grimshaw. J. B. Lippincott Bros., Philadelphia. 1896. Flexible covers, $3 50.

Doane, F. W. W. City Engineer, Editor. Annual Reports of the Several Departments of the Civic Government of Halifax, for the Civic Year 1894–95. Paper.

Holmes, F. M. Celebrated Mechanics and their Achievements. Fleming H. Revell Co., New York and Chicago. Cloth, 75c.

Chambers, W. Mathematical Tables. Edited by James Pryde. New ed. D. Van Nostrand Co., New York. 1896. Cloth, $1.75.

Giddings, Franklin H. The Principles of Sociology. Macmillan & Co., New York. 1896. Cloth, $3.

Paterson, G. W. Lummis. The Management of Dynamos. Imported by C. Scribner's Sons, New York. 1896. Cloth, $1.40.

Nicholson, J. Shield. Strikes and Social Problems. Macmillan & Co., New York. 1896. Cloth, $1.25.

Nye, Alvan Crocker. A Collection of Scale Drawings and Sketches of Colonial Furniture. W. Helburn, New York. 1896. Half leather, $16. Cloth, portfolio, $14.

Robinson, W. The English Flower Garden. New 4th ed. Imported by C. Scribner's Sons, New York 1896. Cloth, $6.

Statham, H. H. Architecture for General Readers New cheaper ed. Charles Scribner's Sons, New York. 1896. Cloth, $2.

Taggart, W. Scott. Cotton Spinning. Vol. 1. Including all processes up to the end of carding. Macmillan & Co., New York. 1896. Cloth, $1.75.

Redgrave, Gilbert R. Calcareous Cements. Imported by J. B. Lippincott Co., Philadelphia. 1896. Cloth, $3.

Sadtler, S. P. A Handbook of Industrial Organic Chemistry. 2d ed. revised and enlarged. J. B. Lippincott Co., Philadelphia. 1896. Cloth, $5. Half leather, $5.50.

Sexton, A. Humboldt. An Elementary Text-Book of Metallurgy. J. B. Lippincott Co. 1896. Cloth, $2.50.

Turner, T. The Metallurgy of Iron. Imported by J. B. Lippincott Co., Philadelphia. 1896. Cloth, $5.

Wegman, E. The Water Supply of the City of New York. John Wiley & Sons, New York. 1895. Cloth, $10.

Wurtz, C. Adolphe. Elements of Modern Chemistry. J. B. Lippincott Co., Philadelphia. 1896. Cloth, $1.80. Sheep, $2.15.

Biddle, W. G. L. Social Regeneration. Student Publishing Co. Hartford, Conn., 1896. Cloth, $1.

Chester, A. H. Dictionary of the Names of Minerals, Including Their History and Etymology. John Wiley & Sons, N. Y. 1896. Cloth, $3.50.

Houston, Edwin J., and Kennelly, Arthur Edwin. Electromagnetism. The W. J. Johnston Co., New York. 1896. Cloth, $1.

Mason, W. P. Water Supply Considered Principally from a Sanitary Standpoint. John Wiley & Sons, N. Y. 1896. Cloth, $5.

Oldknow, Reginald, C. The Mechanism of Men of War: A Description of Machinery found in Modern Fighting Ships. Macmillan & Co., New York. 1896. Cloth, $1.50.

Rousiers, Paul de. The Labor Question in Britain; With Preface by H. De Tourville (translated by F. L. D. Herbertson). Macmillan & Co., New York. Cloth, $4.

Baker, M. N. Sewerage and Sewage Purification. D. Van Nostrand Co., New York. 1896. (Van Nostrand's Science Series, No. 18.) Boards, 50 cents.

Bowmaker, E., M. D. The Housing of the Working Classes, with Plans and Diagrams. C. Scribner's Sons, Importers, N. Y. 1896. (Social Questions of To-Day, No. 18.) Cloth, $1.

Cotterill, J. H. The Steam Engine Considered as a Thermodynamic Machine. Spon & Chamberlain, New York. 1896. Cloth, $4.50.

Cunningham, W., D. D. Modern Civilization in Some of its Economic Aspects. C. Scribner's Sons, New York. 1896. (Social Questions of To-Day, No. 17.) Cloth, $1.

Lieckfield, G. Practical Handbook on the Care and Management of Gas-Engines. Authorized Translation, and Chapter on Oil-Engines, by G. Richmond. Spon & Chamberlain, New York. 1896. Cloth, $1.

Reno, Conrad. Employers' Liability Acts. Houghton, Mifflin & Co., Boston. 1896. Cloth, $5.

Williams, C. R. Bankers' Encyclopedia. The Bankers' Encyclopedia Co., Chicago, 1896. Cloth, $6.

Birkmire, W. H. The Planning and Construction of American Theaters. John Wiley & Sons, New York. 1896. Cloth, $3.

Comey, Arthur Messinger. A Dictionary of Chemical Solubilities (Inorganic). Macmillan & Co., New York. 1896. Cloth, $5.

Del Mar, Alex. History of Monetary Systems. (2d revised edition) C. H. Kerr & Co., Chicago. 1896. Cloth, $2.

Lewis, Eugene C. A History of the American Tariff, 1789-1860. C. H. Kerr & Co., Chicago. 1896. Paper, 25 cents.

Radford, Cyrus S. Handbook on Naval Gunnery. Prepared by Authority of the Navy Department for Use in the U. S. Navy, U. S. Marine Corps, and States Naval Reserves. (2d edition, revised and enlarged with the assistance of Stokely Morgan.) D. Van Nostrand Co., New York. 1896. Leather, $1.50.

BOOKS RECEIVED.

Brown, Geo. R., Gen. Supt., Fall Brook R. R. Discipline Without Suspension. A new method of dealing with the operative force on American Railroads. Press of Locomotive Engineering. New York. 1896 (Railway Service Improvement Series, No. 21). Paper, 10c.

Francis B. Crocker, E. M., Ph. D., Professor of Electric Engineering in Columbia University. Electric Lighting. Vol. I. The Generating Plant. D. Van Nostrand Co. New York. E. & F. N. Spon, London. 1896. Cloth. $3.

Reynolds, Orville H., M. E., Associate Editor Locomotive Engineering. How to Save Money in Railroad Blacksmith Shops by the Use of Bulldozers and Helve Hammers. Press of Locomotive Engineering. New Vork. 1896. Paper. 25c.

Proceedings of the Seventh Annual Convention of the American Boiler Manufacturers' Association held at Boston, Mass., July 8, 9, 10, 1895. Paper.

A Commercial Tour (Programme) to South America. Published and Distributed under the Auspices of the National Association of Manufacturers of the United States.

Tuttle, Herbert B., Chemistry at a Glance. A study in Molecular Architecture (Series). D. Van Nostrand Co. New York. Spon & Chamberlain, New York. 1896. No. 1. Oxides. Paper. 60c.

Johnston's Electrical and Street Railway Directory for 1896. The W. J. Johnston Co. New York. $5.

Missouri Botanical Garden. Seventh Annual Report. Published by the Board of Trustees. 1896.

Report of the Board of State Engineers of the State of Louisiana, April 20, 1894, to April 20, 1896.

Consular Reports, May, 1896. Government Printing Office, Washington, D. C. 1896.

Cox, Walter Gibbons, C. E. Artesian Wells as a Means of Water Supply. D. Van Nostrand Co., New York. $3.

Annual Statistical Report of the American Iron and Steel Association. American Iron and Steel Association. Philadelphia. 1896.

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Burton, Francis G. Engineering Estimates and Cost Accounts. The Technical Publishing Company, Limited, Manchester, Eng. Cloth, 3s.

Clowes, W. Laird. The Naval Pocket-Book. With Plans. Corrected to Jan. 1, 1896. Addenda to Feb. 1, 1896. Tower Publishing Co., Ltd., London. Cloth, 5s.

Drury College, Springfield, Mo., U. S. A.=Annual Catalogue 1895-96.

Cumberland Manufacturing Company, Boston, Mass., U. S. A.=Pamphlet illustrating and describing the Warren Filter for use in water works and in industrial arts.

Bryan & Humphrey, St. Louis, Mo., U. S. A. =Circular in pamphlet form announcing the business of the firm as consulting, mechanical, and electrical engineers. Sets forth the educational qualifications for and experience in these lines of engineering for each member of the firm, their outfit for doing reliable and accurate examinations and tests, and presents a long list of first-class references.

P. Blakiston Son & Co., Philadelphia, Pa., U. S. A.=Catalogue of Chemical, Technological, and Scientific Books, including books on microscopy, water analysis, milk analysis, hygiene, toxicology, etc.

National Paint Works, Williamsport, Pa.= Pamphlet entitled Facts, Experience and Results. Wood and Metal Decoration and Preservation.

Announcement of Courses of Instruction in The Summer School for Teachers and Advanced Students. Cornell University. 1896. Cornell University, Ithaca, N. Y.

Wiechmann, Ferdinand G., Ph.D. Lecture Notes on Theoretical Chemistry. 2d Ed. revised and enlarged. John Wiley and Sons, New York. 1895. New York. Cloth, $3.

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Schimpf, Henry W., Ph.G. A Text-Book of Volumetric Analysis. John Wiley and Sons, New York. 1895. Cloth, $2.50.

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NEW TRADE CATALOGUES.

The Q & C Company, Chicago, Ill., U. S. A.=Pamphlet illustrating and describing the Dunham and Q & C Trolley Freight Car Doors, and setting forth its numerous advantages. Added to the general description is an illustrated list of Dunham door parts, and also a list of the Q & C door parts, with price lists of separate parts, and also illustrated list and price list of such parts as may be used with both the Dunham and Q & C doors.

Gorton & Lidgerwood Co., New York, U. S. A.=Large pamphlet principally directed to the description, illustration, and listing of the Gorton Side-Feed Boilers; but also, in large part, containing valuable information upon the subject of heating broadly. A valuable feature is the persentation of carefully considered forms for specifications for steam and hot-water heating contracts. An interesting feature is the array of

first-class testimonials to the satisfaction given by the heating boilers supplied by this firm to large and small buildings in all parts of the United States.

Fourteenth Annual Catalogue of the Rose Polytechnic Institute, Terre Haute, Ind , with outline of the course of study and the plan of instruction.

B. F. Sturtevant Co., Boston, New York, Pailadelphia, Chicago, U. S. A.=Book of 169 pages. A Treatise on the Principles and Application of Ventilation and Heating. Though this book partakes of the nature of a trade publication, and is properly classed as such, it nevertheless contains a large fund of up-to-date information upon the art of heating and ventilating by forced circulation, now rapidly taking front rank, in methods for buildings of more than ordinary size, as well as for dwellings of the refined character. A valuable feature of the treatise is the space devoted to illustration and description of important and successful installments of this sort, among which figure conspicuously, large manufacturing works, prisons, schools, hospitals, asylums, libraries, and other public buildings.

Marine Iron Works, Chicago, Ill., U. S. A.= Pamphlet illustrating and describing marine machinery and complete steam yachts and launches. Full, detailed information is given, enabling any one to make a judicious selection adapted to special requirements.

The Lidgerwood Manufacturing Company, New York, Boston, Chicago, U. S. A.=Pamphlet illustrating and describing the Lidgerwood Rapid Unloader, used for unloading ballast, dirt, etc., from flat cars in railroad work. A new and very useful device, which, drawn over the tops of the platforms of the cars, scrapes off and throws to one side the material placed on them, the locomotive supplying the needed power. Every railroad contractor ought to investigate the merits of this invention, claimed to be able to discharge a whole trainload of frozen clay in seven minutes.

The Dayton Globe Iron Works, Dayton, Ohio, U. S. A.=Catalogue presenting illustrated description of the New American Turbine, for which many points of superiority are claimed.

B. F. Sturtevant Co., Boston, New York, Chicago, Philadelphia, U. S. A., and London, Eng.=Illustrated Catalogue of the Sturtevant Improved Stationary and Portable Forges, Blowers, Exhausters, Blast Gates, Tuyeres, Hoods, Piping, etc. A fine catalogue.

J. F. Pease Furnace Company, Syracuse, N. Y., U. S. A.=Thirteenth Annual Catalogue illustrating and describing Combination Heaters, Steam Heaters, Hot-Water Heaters and Warm-Air Furnaces, with tables of capacities and data, and descriptions of details.

R. D. Wood & Co., Philadelphia, Pa., U. S. A. (Constructors of gas and water works)= Quarto book of 112 pages (boards). Illustrates and describes water and gas-works appliances,—a fine line,—with price lists and tabulated data. It also contains a carefully prepared essay on water supply, in which a comprehensive discussion of important practical points is comprised.

Johnson Lundell Electric Company, New York, U. S. A.=Pamphlet entitled "Solution of the Municipal Street Railway Problem," discussing broadly the disadvantage of the trolley and other contact systems for propelling street railway cars, and setting forth the advantages of the underground, hermetically sealed, and highly insulated conductor which is the basis of the system that this company is bringing into public notice, and that they claim to be the complete solution of the street railway problem.

The L. S. Starrett Company, Athol, Mass., U. S. A.=Catalogue No. 14, illustrating and describing an extensive line of fine mechanical tools, milling cutters and, other cutters, with price lists.

New York and Rosendale Cement Co., New York, U. S. A.=Circulars setting forth the desirable qualities of the "Brooklyn Bridge" brand of Rosendale hydraulic cement, and presenting a list—headed by the New York and Brooklyn Bridge,—of large public works, bridges, buildings, reservoirs, etc., in which this cement has been used.

Pemberthy Injector Co., Detroit, Mich., U. S. A.=The Pemberthy Bulletin for April. Discusses boiler explosions; a new theory of the strength of boilers; heat and steam. Hints for owners and managers of steam boilers.

D. Van Nostrand Co., New York, U. S. A.= Catalogue of books on electricity, electric light, the telephone, electro-motors, electric-telegraph, electro-metallurgy, etc.

Krotz, Allen & Kelly, Springfield, Ohio, U. S. A.=Illustrated pamphlet describing and setting forth advantages of the K. A. K. Electric System for steam railways, elevated railways, and street railways.

Case School of Applied Science, Cleveland, Ohio, 1896.=Pamphlet describing the department of mechanical engineering, with schedule of the course, and illustrated descriptions of its outfit of machinery, shops, testing laboratory, etc.

Lafayette Engineering and Electric Works, Lafayette, Ind., U. S. A.=Illustrated catalogue of Dynamos, Arc Lamps, and Electrical Specialties.

International Correspondence Schools, Scranton, Pa., U. S. A.=First number of *Journal of The International Correspondence Schools*, in which, among other interesting and instructive matter, is a table showing occupations and ages of 9,255 students.

Gates Iron Works, Chicago, Ill., U.S.A.= Catalogue No. 1, 3d edition. May, 1896. Illustrates and describes the Gates rock and ore breakers with names and code-names of parts and price list, also a list of catalogues, 1 to 10 inclusive, issued by this firm.

Rue Manufacturing Co., Philadelphia, Pa, U. S. A.=Catalogue illustrating and describing the "Little Giant," "Fixed Nozzle," and "Unique" injectors, boiler-washing and testing apparatus, etc.

The A. Lietz Co., San Francisco, Cal., U. S. A.=(a) "Manual of Modern Surveying Instruments, and other scientific instruments." Price 50 cts. (b) Pamphlet and price list illustrating and describing the cyclotomic transit.

Wm. J. Baldwin, M. E., 277 Pearl Street, New York, U. S. A.=Pamphlet on "The Separation of Grease from Exhaust Steam," illustrating and describing Baldwin's grease separator with price list and testimonials from users.

Steward and Romaine Mfg. Co, Ltd., Philadelphia, Pa., U. S. A.=Illustrated catalogue and price lists of iron and brass expansion bolts.

Follansbee Brothers Co., Pittsburg, Pa., U. S. A.=Account of the Trade-Mark Litigation Follansbee Brothers Company vs. John T. Morris and Charles F. Lane, doing business as the Morris and Lane Furnace Company in the matter of alleged infringement by the latter of the trade mark of the former, to wit, "Scott's 1 C Extra Coated" stamped on tin plates manufactured by the plaintiff, in the Circuit Court of the United States for the Northern District of Ohio, Eastern Division. Judgment for plaintiff.

Stow Manufacturing Co., Binghamton, N. Y., U. S. A.=Catalogue No. 6, illu-trating and describing the Stow Flexible Shaft for Portable Drilling, Tapping, Reaming, etc., and tools used in connection therewith, with price lists, repair lists, and other useful information relating to this excellent shop device.

H. Channon Company, Chicago, U. S. A.= Catalogue illustrating, describing and presenting price lists of a long and extensive line of Contractors' and Railway Supplies. The extent of this line of goods may be inferred from the size of the catalogue, 246 octavo pages.

Snow Steam Pump Works, Buffalo, N. Y.= Large quarto pamphlet, entitled "Wayside Water Works." A most elegantly illustrated and printed trade publication, with engravings of pumping engines on alternate pages, the page opposite each pump engraving having a beautiful art engraving with appropriate text.

Ferracute Machine Co., Bridgeton, N. J., U.S.A.=Leaflet, infolding. A sheet illustrating and describing presses for use in manufacturing bicycles and cycle fittings, sewing machines, hardware implements, etc. Full data of sizes and capacities. The president of this company is the author of "Press-Working of Metals," a book of 276 pages, 8vo, and 433 engravings. Published and sold by John Wiley & Sons, New York. $3.

American Blower Co., Detroit, Mich., U.S.A. =Pamphlet containing illustrated descriptions and price lists of the "A. B. C." patent disc ventilating fan, and the "Cyclone" ventilating fan, manufactured by this company.

The Hoppes Mfg. Co., Springfield, Ohio, U.S.A.=Catalogue illustrating and describing the Hoppes live steam feed-water purifiers, and the Hoppes lime extracting exhaust feed-water heater, with extensive list of important establishments using these appliances, with capacities from 50 to 2500 H. P. Also table of economies secured by feed-water heating. Also table of dimensions of purifiers corresponding to different capacities.

Boston Belting Co., Boston, Mass., U. S. A., and New York.=Catalogue illustrating a long line of rubber belting, packing, hose, hose-reels, and other appliances, and a variety of other rubber goods.

C. W. Hunt Company, New York.=Elegantly printed and illustrated pamphlet entitled "Manilla Rope for Transmission and Hoisting." A brief treatise for engineers, on ropes used for the transmission of power, together with formulæ, tables, and data useful in mill engineering. Appended is a list of well-known users of "Stevedore" rope manufactured by this company.

The Jeffrey Mfg. Co., Columbus, Ohio, U. S. A.=Catalogue for 1896. Illustrating and describing the Jeffrey patented coal mining machines, drills, electric mine-locomotives, elevating and conveying machinery, and complete coal-mine equipments.

The Lunkenheimer Co., Cincinnati, Ohio, U. S. A., New York and London.=Pocket Edition Catalogue, 1896, of brass and iron valves, lubricators, and steam specialties. Illustrated descriptions and price lists.

The Phosphor Bronze Smelting Co., Philadelphia, Pa., U. S. A.=1896. Price List No. 10.

American Industrial Publication Co., Bridgeport, Conn., U.S.A.=Catalogue, 1896. Industrial, scientific, and technical publications.

The Deane Steam Pump Co., Holyoke, Mass., U. S. A.=Illustrated description of pumping plant installed by this company at Andover, Mass., with trial test and data. The vertical cross compound high duty pumping engine built by the company is the one used at Andover. The test was made March 4 of the present year, and an average higher duty than was obtained in the test up to May 14, is certified to by the superintendent of the Andover works.

The Lodge & Shipley Machine Tool Co., Cincinnati, Ohio, U. S. A.=Illustrated, detailed descriptions of an improved line of engine lathes.

American Well Works, Aurora, Ill., U. S. A., and Dallas, Tex., U. S. A.=Statements of people using tools manufactured by this company, with price lists of steam, gas and water-pipe, including X and XX strong pipe and standard boiler tubes. Also illustrations of gas or gasoline engines.

IMPROVED MACHINERY

NEW PROCESSES. NEW APPLIANCES.

The matter published in this department is not paid for, nor can it be classed as advertising. But as the information is necessarily obtained from those who offer the appliances for sale, it is proper to say that the manufacturers, rather than ourselves, are responsible for the statements made.

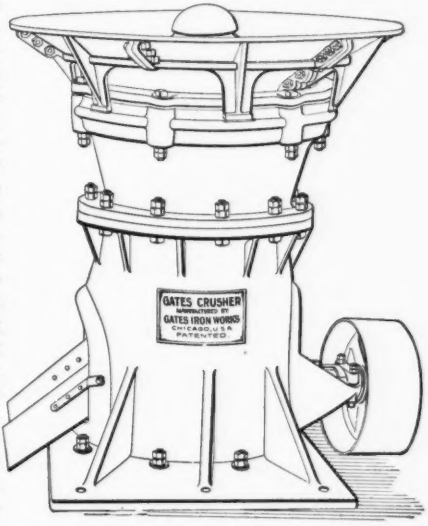
The Gates Rock and Ore Breaker.

THE engraving shows one of the most successful machines yet produced for crushing rock and ore. Two styles of the machine, respectively called styles "B" and "D" are made, the style "D" embodying the latest improvements. These improvements, however, comprise no change in principle, and the two styles are in their essentials the same. The improvements embodied in Style "*D*" are, however, an important advance from the first type.

The style "D" dispenses with the oak-frame which hitherto has formed the base of the machine, by dropping the bottom plate together with the eccentric box and gear wheel, so that the operator can get at the working part of the breaker without taking up the entire machine. This is the main difference between the two styles, the newer style also obviating the danger of the countershaft getting out of line. The main bearing of the countershaft is cast on the bottom shell, and is of ample size and length. This bearing, being thus made an integral part of the shell, can not get out of alignment. The bearing is constructed with ample oil reservoirs and chain oilers, and a mandrel for rebabbitting this box, is sent with each machine, thus putting the means of repair in the hands of the operator, and assuring a perfect job. The countershaft will in most cases be extended beyond the pulley so that the operator may attach gearing if desired for running elevator and screen, in which case an outboard bearing may be put on.

The machine is a breaker of the gyratory form. The word gyratory partially explains the mechanism. The crushing is done between a cone placed on a gyratory shaft vertical through the center of a cylindrical shell. As it gyrates, the crushing cone impinges against the sides of the shell in relation to which it is constantly approaching and receding. The top of the shaft carrying the crushing cone is held rigidly, while the bottom is gyrated (with a certain amount of eccentricity, depending upon the size of the machine) by means of a simple gearing.

The crusher commonly called the "jaw breaker" was the only practical one existing up to the date of the introduction of the Gates gyratory crusher. In its time the "jaw breaker" was justly considered a great invention; but the superiority of the Gates machine is sufficiently proved by the fact that, in a fair competition with the older machine, four thousand of the Gates are now in operation in all parts of the world. Its capacity is claimed to be no less than three times that of the jaw breaker. The diameter of its "breaking head" corresponds very nearly to the width of the jaw in the old style jaw breaker receiving the same size stone; and as the circumference of the head of the Gates machine is over three times the width of the jaw in the jaw breaker, and makes a complete gyration in the same time it takes the jaw crusher to approach and recede, the Gates Breaker must necessarily operate on three times as much material in a

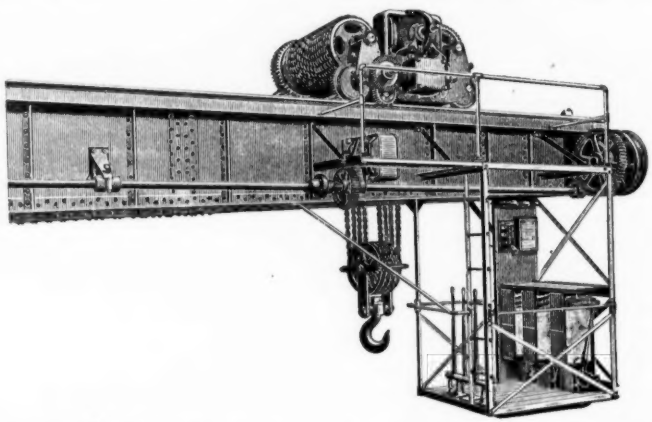


THE GATES ROCK AND ORE BREAKER.

given time. Moreover, authenticated public trials have shown that it requires thirty per cent. less power than the "jaw breaker" under the same conditions.

The manufacturers, Gates Iron Works, 1112 Masonic Temple, Chicago, Ill., are in possession of thousands of testimonials confirming the efficiency, durability and convenience of these machines.

They are now substituting—to special order—manganese steel for chilled white iron in the crushing surfaces for dealing with the harder rocks, such as granite and trap for road metal, etc. Some of these machines can produce one hundred and fifty tons of road metal per hour. Catalogue, No. 1, May, 1896, describing the two styles of machines named, is most complete and well arranged, and gives the fullest information to enquirers.



The Shaw Electric Travelling Crane.

IN our current series of Machine Shop papers, Mr. H. L. Arnold has said: "The advent of the Electric driven travelling crane revolutionized shop construction for heavy work; the use of this admirable application of electric power transmission effected such savings in handling work as to force its installation in every new shop. * * * * For all shops handling pieces of as little as 500 lbs. weight even, the travelling crane is needed, and, where work reaches into ordinary steam engine proportions, this agent is indispensable."

With the advent of the Shaw crane (Jan., 1889), in which neither of the three actions is in any way dependent on any other, the full measure of the usefulness of the travelling crane became so prominently apparent that this agent could not be overlooked, and the universal installment of the independent motor travelling crane has now made it so familiar a part of machine shop equipment as to render its detailed description almost needless. The engraving shows a 3-motor Shaw crane of the usual type.

The speeds are for the hoist trolley bridge without load, 60 ft., 125 ft., 350 ft., and Loaded 20 ft., 100 ft., 300 ft., per minute.

The girder flange stresses are 10,000 lbs. per sq. in. of section in tension, and 5,000 in compression. The enclosed cage for the driver is at one end below and at one side of the bridge, so as to clear the hook travel.

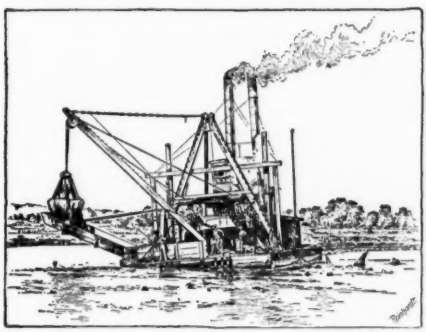
Trolley hoisting drum grooved right and left to wind on both ends of the chain, and of ample diameter to avoid chain friction, and secure durability. Shaw's patent automatic brake gives perfect protection against the running down of the weight. Only two speed reductions between the motor and chain drum are employed, thus ensuring high lifting efficiency. The trolley is carried on four double-flanged truck wheels; the chain is of special iron, having an ultimate strength of 53,000 pounds per square inch, and tested to double the working strain. The hook, of ample size and throat opening, is of refined wrought iron. The ratio between the chain pitch and the pitch diameter of the sheaves is large, thus insuring durability and high efficiency through reduction of chain angles and friction. The grooves are turned, and the hubs have bronze bushings. All gears, except main hoisting drum gears and drum-gear pinions, are cut. All bearings are ample, and have compression grease cups, which deliver grease before the melting temperature is reached. These cranes

have one independent electric motor, one for each movement, each completely controlled by one of three levers in the cab, levers being considered more certain in action than operating wheels. The simplicity of the three-lever arrangement avoids error in direction of motion by the attendant.

The direction of any movement depends on the position—one side or the other—of the center of lever movement of the controlling lever, and on the distance the lever is moved away from the mid-position. The motor is the Shaw Crane Company's own construction, and large enough to easily handle maximum loads at maximum speeds. The controllers are Shaw patent, fire-proof rheostats, of abundant capacity. No readily fused or ignited constructions or materials are used in the rheostats, only slate, mica, iron, and copper being exposed to heat. Detail parts are interchangeable. The cranes are provided with all switches, cut-outs, and other electrical apparatus needful for safe and convenient handling and operation, and all wiring is thoroughly insulated, and of ample carrying capacity. The electrical work is designed throughout for a force of 220 volts.

Vacuum Pump Dredging Machine.

A DREDGE is now operating at Bergen Beach, Long Island, in forming a channel and a desirable beach along a hitherto unavailable waterfront and, at the same time, reclaiming adjacent low lands. This machine,—shown in the accompanying cut,—has many points of superiority over other dredges which make its work unique and noticeable. The usual bucket elevates the material and discharges it into a hopper where jets of water reduce it to a consistency for passage through the pump. An immense vacuum pump draws the material into its cylinder, to be discharged by steam pressure through a long line of pipe to the point where the material is to be utilized. At Bergen Beach one hundred acres of hitherto worthless area has been reclaimed, the surface being left practically level by the machine. It is now operating through 1200 feet of 15-inch pipe and the discharge from the mouth of the pipe is fully 90 per cent. of solid matter.



This system is specially applicable to the dredging of inland lakes where the disposal of material is generally a difficult problem. The company operating and controlling this system,—The Babcock-Lary Dredging Co., of 29 Broadway, New York,—recently finished a remarkable work in dredging out Washington Lake which furnishes the water supply for the city of Newburgh, N. Y. This was accomplished at a time when the water supply was low, and great care had to be used to economize water and prevent fouling of the supply. That this was done to the entire satisfaction of the officials is shown by the appended letter :

BABCOCK-LARY DREDGING CO.,
29 Broadway, New York.

DEAR SIRS: The work done by you in 1892-93, in dredging out the muck from Washington Lake, which forms the reservoir of this city, was successfully done in the face of exceptional difficulties. At the time of dredging the water was very low, and it was necessary to use every precaution to avoid soiling the water. The bottom of the lake was covered with boulders, rough, and uneven, and the dumping grounds were from 1000 to 3000 feet above water. After examining several methods, the engineers selected the one finally proposed and used by you. Including the work done by hand, about 350,000 cubic yards were removed,—the greater part by dredging. I do not think any better method could have been devised to accomplish this work ; it was expeditious, cheap and successful.

JOHN D. VAN BUREN,
Chief Engineer, Newburgh Water Works.

Coal Storage Plant at East Buffalo.

THE Erie R. R. having contracted with the Dodge Coal Storage Co. of Philadelphia, for a 150,000-ton storage plant, on the Dodge system, to be erected at East Buffalo, the plant will consist of nine divisions or piles of about 17,000 tons capacity each, of which six will be equipped at once, and the others probably before the end of the year. The general appearance of the complete plant, is shown in the accompanying photograph.

This system has been in use for storing and reloading coal for eight years, and plants now in operation have an aggregate capacity of 1,455,000 tons. The plants are owned and operated chiefly by coal roads whose terminals are in the vicinity of New York and Philadelphia. Evidence of the utility of the system is found in the fact that each of the roads using it has at least two plants.

Mechanically the Dodge system consists of,—first; a chain conveyor mounted upon one leg of a steel truss, standing at an angle with the ground corresponding closely to the natural angle of repose of the coal, and beneath which the coal is stored. The conveyor is extended beyond the foot of the truss to receive the coal by gravity from a hopper beneath the track on which the discharging car stands, and, in operation, drawing the coal from this hopper, it begins depositing it upon the ground at the foot of the truss. The bottom of the conveyor being pivoted portion of the reloader is supported by circular rails and adapted to be moved by power to the base of either of the two coal piles. A continuous, reversible chain conveyor, equipped with flights, slides the coal from either pile and with one continuous motion to the tower at head of incline, and both it and the reloader are operated and controlled by one man on a platform at the pivotal point.

The handling of the coal, though frequently in excess of three tons per minute, is gentle, and the breakage insignificant,—a very important consideration, and a large factor in the adoption of the system, which has also very greatly reduced the cost of storing and reloading.

In the plant at East Buffalo, the nine coal piles will be located along a straight line, and, with the tracks required, will occupy a space 2100 ft. × 336 ft. There will be three tracks on either side, running lengthwise of the plant and provided with numerous cross-overs. Stocking

COAL STORAGE PLANT AT EAST BUFFALO.

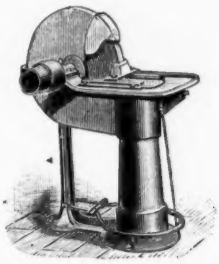
formed of a steel ribbon which is only drawn out toward the apex of the truss as the pile of coal gradually increases in size, no fall and resulting breakage of coal is permitted. The completed pile is of conical form. Between each two piles is located the second element of the system,—the "reloader." This consists of a horizontal portion pivoted at one end, and of a length sufficient to permit its being swung entirely across the ground occupied by the coal piles to the right and the left. From the pivotal point the reloader is inclined upward and terminates in a tower equipped with a screen and hopper, from which the coal, through an adjustable chute, is delivered into cars on the reloading track. The out will be exclusively from cars received on one side of the plant, and reloading will be done wholly on the other side. The hoppers tributary to the trimmers will be on the receiving side of the central track,—the inside and outside tracks being auxiliaries for drilling cars. On the reloading side, cars receiving coal will be located on the middle track. The outside track will be an auxiliary, and the innertrack, which is under the reloading towers, will be used for handling cars to be loaded with screenings. The arrangement has been very carefully worked out with a view to increasing the efficiency and speed of the plant over any of its predecessors, through greater facilities for handling the cars. A com-

plete haulage system will encircle the plant, to make this rapid handling of cars practicable,—all movement of them being effected by this means from the time the trains are delivered at the plant until the reloaded cars are again made up into trains to go out.

Barnes' Water Emery Grinder.

THE accompanying engraving represents an improved method of mounting an emery wheel, which, it is claimed, possesses superior advantages. To the front of the treadle (which is pivoted to the rear standard and bent to encircle the water column) is attached a lever whose free end carries a float. Pressing the foot upon the treadle causes the float to enter the water chamber, displacing the water, and forcing it to rise and supply the wheel. When not in use the float rises, and the water settles back. There are no pumps or valves, liable to get out of order, and the machine is thus simplified and made more practicable under all conditions.

The chamber in which the float is suspended —resting upon the water—is divided from the chamber in which the wheel revolves by a partition, in the lower part of which is a small hole

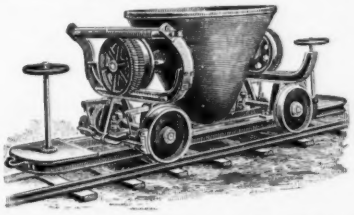


through which the water slowly enters the wheel chamber. The action of the wheel carries the water to its front upper quarter, where it is arrested and thrown into a pocket (shown in the engraving by the outer shell broken away) whence it falls on the wheel and tool. Otherwise the water would be flooded in to the wheel in a body or rush, which would not be desirable. The small hole in the bottom edge of the partition, allows the water to flow back into the reservoir when the float rises. The curved treadle can be conveniently reached, no matter what position the operator may assume when grinding. This construction greatly simplifies the machine and renders it more efficient, and also allows it to be used in shops where there is no piping.

The pulleys on the grinder are 5½ and 7 inches in diameter by 4 inches face, and on the countershaft 13½ and 10 inches by 4 inches. The proper speed of countershaft is 425; speed of wheel, 600. The W. F. and John Barnes Co., 953 Ruby street, Rockford, Ill., manufactures this useful improvement.

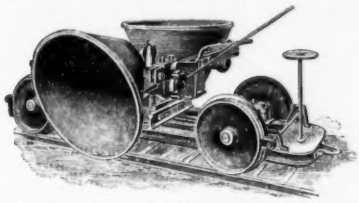
Slag Trucks.

THE Colorado Iron Works Co. of Denver, manufacturers of Blast Furnaces and equipments for smelting Gold, Silver, Lead, and Copper Ores, are making two styles of Slag Trucks (shown in the accompanying cuts) for conveying molten slag from furnace to slag dump. Both are built to run on tracks of three feet gage, and are constructed to allow the pots to dump the fluid slag outside of the track rail. One



style of truck carries two pots, the other only one.

The Single Pot Truck has a capacity of 35.16 cubic feet. Its total height from track is 4′ 6½″. The pot is hung on axles on which are keyed wheels that roll on a track placed transversely on the truck. A screw gear is also keyed to one of the axles of the pot, and a screw, extending across the frame and fixed in boxes at its



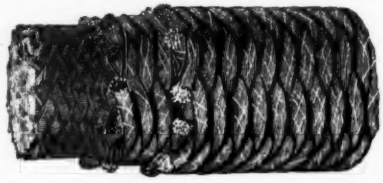
two ends and operated by a hand crank, engages in the gear revolving it, and the pot is thus rolled over on its wheels far enough to pour out all its contents over and beyond the track.

There are some conditions where the large truck cannot be used on account of its height, in which case the double pot truck is used. This latter has a capacity of 7.8 cubic feet to each pot, or 15.6 cubic feet for the two, and its total height from top of track rail is 3′ 2″. These pots

are hung on axles in a frame opposite each other. This frame swings horizontally on a center pin and, when swung around transversely of the truck, the pots overhang the two rails of the track respectively, and are in position for dumping. In most cases the slag is dumped on but one side of the track, which is laid as near to edge of dump as possible and moved out from time to time as dump is filled out; in such cases, after one is dumped, the frame is swung around and the other pot dumped on the same side. Both styles of trucks are fitted with platforms on ends, and brakes for use on down grade when necessary. There are many of these Slag Trucks of both styles in use at the various smelting works throughout the country. Many of them are drawn by locomotives. In other places they are drawn by mules; in several instances they are handled by stationary winding engines —a wire rope running from the drum on the engine out around a sheave on slag dump at end of track, and thence back along the track to the furnaces.

Semibronze Packing.

THIS is a new high-grade packing for engines and pumps, manufactured by the N. J. Car Spring & Rubber Company, Jersey City, N. J. The core is the foundation of the packing, and is a lubricator reservoir composed of loosely-spun asbestos thoroughly saturated with high-grade cylinder oil, pressed into the desired shape, and coated with pure foliated graphite. The covering consists of alternate strands of hemp and

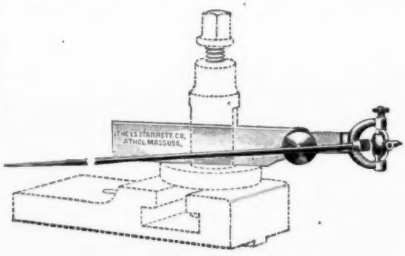


asbestos, loosely spun, each braided over with an open work of very fine brass wire.

All of the strands are very loose and fluffy, so that they will readily soak up oil and hold it, and the braiding of the wire being, quite open, permits the oil to flow readily from the fibre and carry along with it the graphite to the piston rod when heated. Beside serving to hold the soft, fluffy materials together, the wire adds to the lasting qualities of the packing, both by its own resistance to wear when properly lubricated and by reason of its protection of the fibers from being blown out of the stuffing box by steam or water pressure. This packing is used in the same way as common fibrous packings. It is claimed that this packing, in actual hard service, has given entire satisfaction wherever put in, both as to its lasting qualities and the bright appearance of the piston rods. It is put up in twelve-feet lengths, each length in a separate box labeled, and sells at a popular price. Two brands are made,—*viz.*, "Gilt Edge" and "Combination."

Center Tester.

A CHEAP and useful device is illustrated in the accompanying engraving. This tool is one of a line of fine mechanical tools manufactured by L. S. Starrett & Co., Athol, Mass., and is designed for use in adjusting and locating centrally any point or hole in a piece of work operated upon in a lathe chuck or on a face-plate; also to test the truth of lathe centres or a shaft between the centres, the instrument being held in the tool post. The tester is of improved design and nicely made. The indicating needle passes



through the ball, having a split stem, forming a chuck for holding the needle adjusted to any desired length. The ball is pivoted to form a universal joint, but may be instantly converted into a single joint for a tilting motion by only tightening the knurled nut, adapting it for both inside and outside surface contact. A steel bead, not shown in the cut, and carried on the needle, slips over the point of same when used for inside work. The instrument is joined to a tool-post shank by a flexible steel ribbon with sufficient spring to properly hold the needle in contact with the work. It is a tool needed in every up-to-date toolroom.

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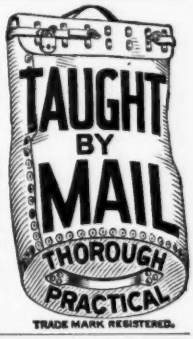

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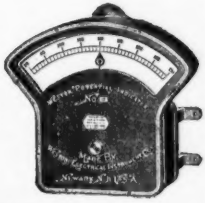

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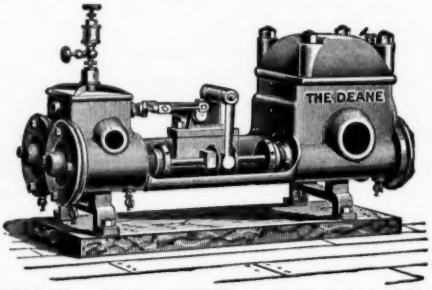

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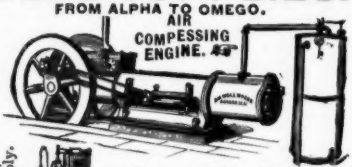

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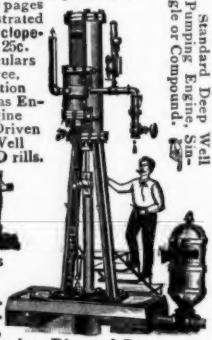

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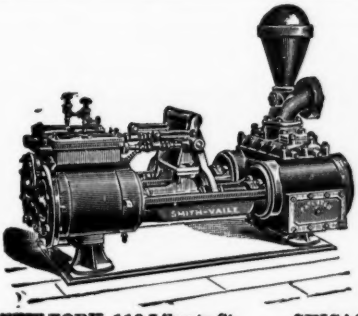

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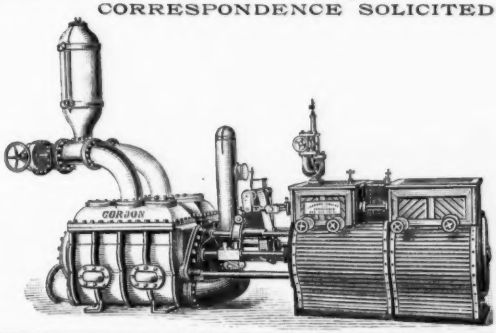

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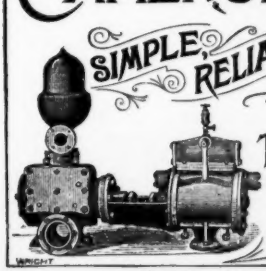

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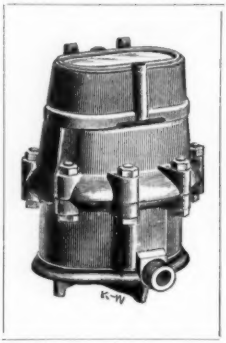

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